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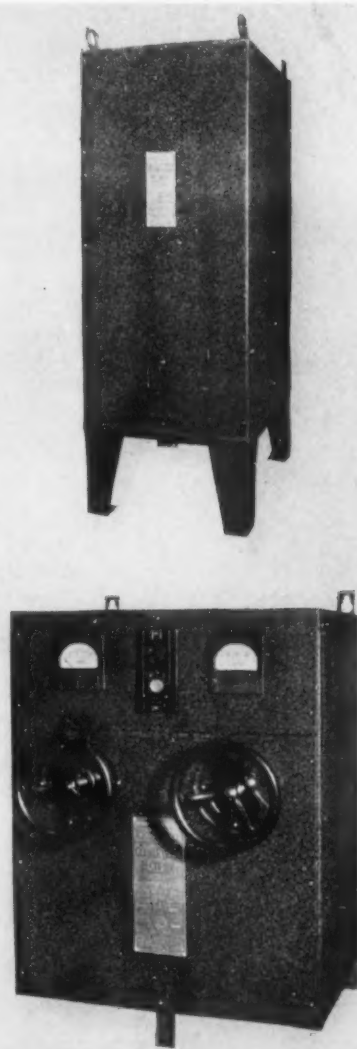
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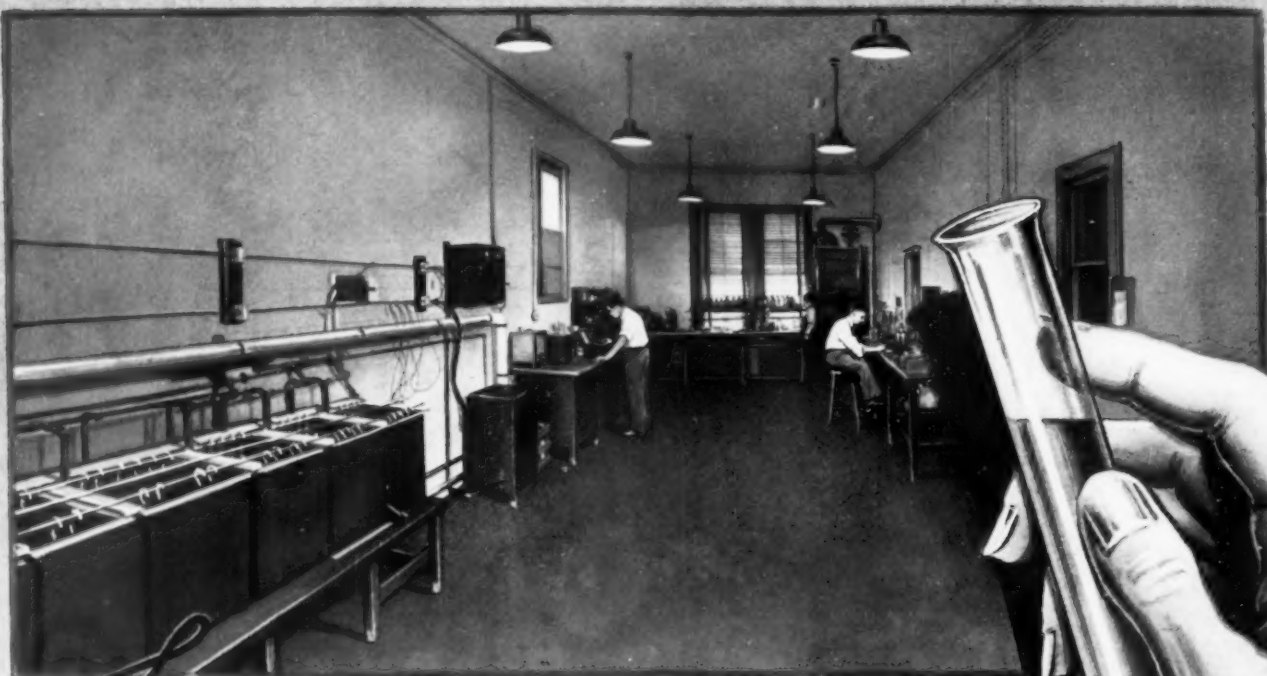
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January, 1903 by
PALMER H. LANGDON
1868-1935

METAL FINISHING

VOLUME 39

MARCH, 1941

NUMBER 3

Publication Office:
116 John Street, New York



L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1941
by The Metal Industry Publishing Company,
Incorporated, 116 John St., New York,
N. Y. Entered February 25, 1903, at New
York, N. Y., as second class matter under
Act of Congress, March 3, 1879. Re-
entered as second class matter June 13,
1940, at the post office at New York,
N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States,
\$2.00 per year; Canada, \$2.50 per year
(includes 50c exchange and tax). Foreign
\$3.00. Single copies 25c. Please remit by
check or money order; cash should be
registered.

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Banded Structure In Electrodeposits

Recently published photomicrographs of Young and others of bright nickel deposits have shown an interesting phenomenon—banded or periodic structure—similar to the rhythmic precipitates observed by R. E. Liesegang in 1896. Banded structure was observed by Macfadyen, in 1910, in electrolytic iron deposits and he attributed the banding to alternate deposition of iron and basic salts and he noticed that the bands disappeared when the iron solution was filtered through activated carbon.

In 1921, Grube and Reuss noticed banded structures in copper that had been deposited from a copper sulfate solution containing gelatin. Moore showed banded structures in cobalt deposits, and Phillips and Meyer observed pronounced banding in deposits obtained from cyanide solutions containing small amounts of lead, thallium, or cadmium. It was once thought that banding may be present in all bright deposits but careful microscopic examination of certain bright copper and zinc deposits has not been able to detect banding. The absence of banding in bright copper may be due to the high cathode efficiency which mitigates against the formation of basic salts.

The non-uniform or periodic structure indicates that the cathode process of electrodeposition is not a smooth continuous process, but at least for the case where the deposits are banded, a fluctuation in the rate of deposition of the metal and any foreign matter occurs. Stillwell and Stout, for example, by the use of X-rays, have determined phases in electrodeposited cadmium-silver alloys which were not indicated as forming, for the percentage composition concerned, on the basis of the equilibrium diagram for cadmium-silver alloys. One would conclude from this that the relative rates of deposition of cadmium and zinc atoms were not uniform but fluctuate considerably.

Phillips and Meyer, by using a recording micro-voltmeter across a bridge circuit with a copper

plating bath in one branch of the circuit, were able to measure minute fluctuations in the resistance of the cathode-solution interface and obtained results in surprising agreement with the potential fluctuation periods calculated from the thickness of bands in the deposits as determined by the microscope. It was found that, for acid copper solutions, the deposition was smooth with no evidence of periods in the film resistance, but for cyanide solutions, the film resistance would build up gradually and then there would be a sharp drop in the resistance. A non-uniform fluctuation was observed for cyanide copper solutions without foreign metal, and deposits from the pure cyanide copper solution showed no evidence of banding. However, when lead, cadmium, or thallium were added to the copper solution, a distinct periodicity occurred in the film resistance and these periods could be correlated with the thickness of bands in the electrodeposits.

From the evidence cited above and from other evidence, it appears that when deposition of a metal occurs with the co-deposition of another metal or foreign substance capable of being adsorbed or being discharged electrically, the metal ions are first discharged, and after this discharge has proceeded for a definite time, the rate of diffusion of the ions cannot keep up with the rate of discharge, and the potential necessary to discharge the metal increases until the second metal or substance is discharged, with the same process repeating. It is not expected, however, that complete deposition of one metal takes place at any one time to the complete exclusion of the other metal or substance.

This phenomenon has been mentioned with the hope that research workers will continue the study of the mechanism of deposition for banded and bright deposits, as the writer believes that the surface has only been scratched by the studies made to date.

Adherent Copper Deposits on Austenitic Chromium-Nickel Steels*

BY H. T. SHIRLEY

Brown-Firth Research Laboratories,
England

A method for obtaining adherent deposits of copper on 12-12 and 18-8 stainless steel is described. The process involves two stages: (1) Reduction of oxide or depassivation by cathodic treatment in a sulfuric acid solution; and (2) Copper deposition in an acid copper solution. The poor throwing power of the acid copper solution limits the process to rather simple shapes.—Ed.

SOME time ago, G. E. Gardam† described a very interesting method for overcoming the difficulties introduced by passivity in obtaining adherent, thin deposits of nickel as a base for further deposition on chromium or stainless steel.‡ As the author explained, even cathodic treatment in sulfuric acid solution has failed to give a surface which would plate satisfactorily, and the desired result was only achieved by using a solution such that film reduction and nickel deposition occurred simultaneously, a considerable proportion of the current being used for the reduction.

Nevertheless, it is possible to obtain an adherent deposit of copper by a two bath process without having recourse to any intermediate coating. Since the deposition of a simple copper coat may in some cases be preferable, and in any case, the observations made during the development of this process throw light on the mechanism underlying the success of the nickel process, it was felt that a short description of the work would be of interest.

It has been known for some time that improved adherence could be obtained by previous immersion of the steel in hot 50 per cent hydrochloric acid solution for a few minutes, until the attack was proceeding freely, but the failure of both this method and the preparation by simple cathodic treatment in sulfuric acid solution suggested either that removal of the film was incomplete, or that it grew again to an appreciable extent even during the brief period required for transfer to the plating bath.

On studying the surface of samples after cathodic treatment and a very brief plating period, it was found that the copper deposition was localized in streaks and small areas. This suggested that initial deposition might occur only where the metallic surface was free from oxide film, or where this film was very thin and comparatively harmless. Acting on this suggestion, specimens were given repeated cathodic treatment followed by a brief plating treatment of 15 to 20 seconds. In this way, after 3 or 4 cycles, it was found that the whole surface had become covered with copper, and a subsequent layer of 0.01" thick deposited in the usual manner showed no signs of flaking when the 18-gauge sheet of steel was fractured by reverse bending.

The experiments have been carried out on a laboratory

scale using specimens 3 by 2 inches of both 12-12 and 18-8 chromium-nickel steel. Under these conditions the following procedure was found to give good results:

(a) Cathodic Reduction Treatment

Bath:

Sulfuric acid 300 g./liter
Temperature Normal room temperature
Current density 27 amperes per sq. ft.

Time, 3 minutes for each treatment, transferring rapidly to the plating bath without rinsing.

(b) Copper Deposition

Bath:

Copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) 220 g./liter
Sulfuric acid 50 "
Temperature 100° C.
Current density 27 amperes per sq. ft.

Time for preliminary treatment, 15-20 seconds on each occasion, rinsing before returning to the reduction bath. Continue the double treatment until copper has deposited over the whole surface. Then plate as usual.

Current density is important. When it was raised to 55 amperes per sq. ft., unsatisfactory adhesion was obtained, the whole specimen becoming coated with copper during the first 15 seconds deposition period. A current density of 14 amperes per sq. ft. was also unsatisfactory.

If the suggested reason for the localized nature of the initial deposition is correct, as seems probable from the good results obtained by the above procedure, it would seem that this forms the basis for the success of both processes for obtaining adherent deposits. In effect, it would appear that the initial deposition occurs only on those portions of the surface where the film is insufficient to prevent adhesion, and the subsequent, or, in Gardam's process, simultaneous reduction is thus able to attack the film responsible for non-adhesion before this becomes covered over with a copper deposit.

*Reprinted from J. Electrodepositors' Tech. Soc. 14, 47 (1938).

† J. Electrodepositors' Tech. Soc., 13 (1937).

‡ A method for treating stainless steel for subsequent plating was discussed by Donald Wood in the July 1938 issue of Metal Industry (now Metal Finishing). Wood recommended a treatment in an acidified nickel solution.—Ed.

SURFACE TENSION PHENOMENA AND SURFACE ACTIVE MATERIALS

By DERICK S. HARTSHORN, JR.

Technical Director,
The Enthone Co., New Haven, Conn.



D. S. Hartshorn, Jr.

The author discusses the phenomenon of surface tension giving the factors affecting the surface tension of aqueous solutions such as temperature, wetting agent additions and salt concentration. The orientive state of polar-nonpolar compounds at liquid interfaces is considered in detail and the relation of specific molecular structure on this state is reviewed. Wetting agents are classified as to structure and various correlated properties are described.—Ed.

Introduction

Electroplating processes are those that distinctively take place at interfaces such as solid-liquid, liquid-liquid and solid-gas, and therefore a thorough understanding of interfacial phenomena should help considerably in understanding and operating electroplating processes. Formerly, the alteration of surface tension conditions was accomplished largely by varying physical conditions such as temperature, but recently, a vast number of surface active materials have been made available to control surface conditions.

It will be shown that surface active materials are of many types and each type possesses characteristic properties, and hence the surface active material should be selected after a consideration of all of the results desired and not on the assumption that all wetting agents are alike. Improper choice of wetting agents has resulted in considerable trouble in the past, but properly selected materials are giving excellent service in plating, acid dipping and cleaning solutions.

Surface Tension

The tendency of liquids to form spherical shapes and other evidence of tension at the surface of liquids such as the rise of liquids in capillary tubes, the floating of water-spiders and water-bugs on the surface of water, have been noticed for many years. The proper understanding of this condition followed the understanding of the molecular structure of matter.

Surface tension effects are shown by both liquids and solids, although actual measurement of interfacial tension of solids is practically impossible. The molecules of both liquids and solids are about the same distance apart, the distance being of the order of from 1 to 5 Ångström units.* Atoms

*An Ångström unit is a unit of length equal to 1×10^{-8} centimeters or 0.00000001 centimeters. The proper abbreviation for Ångström unit is Å.—Ed.

have strong attractions for each other and in the case of solids, the attractive forces are sufficiently orientive to bring about definite order or structure, called "crystal structure." Although some degree of order has been observed in liquids, they are characterized by a uniform or isotropic state without order with the exception of at interfaces.

The intermolecular forces existent in both liquids and solids result directly in the phenomenon called "surface tension" because the molecules directly at the interface, and a few molecular layers below the surface, are attracted by the body of molecules below the surface with a net force effect parallel to the surface. The molecules in the body of the liquid or solid, however, are affected uniformly by the neighboring molecules with no net force effect. (See Fig. 1.) As a result of the net internally directing forces at the

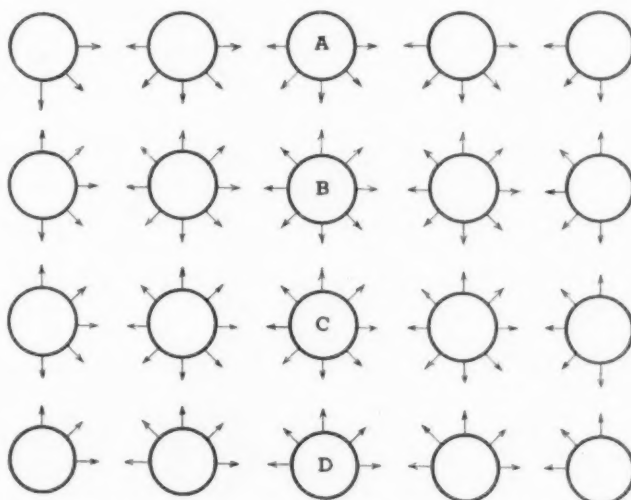


Fig. 1. Drawing illustrating forces existing between atoms of a solid or liquid. Note that there is a net force effect between the molecules at the surface with resultant forces or tension exerted laterally and downward, as illustrated for the molecules in the A row. There may be a slight net effect of forces for the molecules in layer B, but for layers C, D and lower, the forces between molecules are balanced.

TABLE I
Tensions of Typical Mobile Interfaces

Phase A	Temp. °C	Phase B Air + Vapor	Water
Water	20	72.75	
Water	-8	77.0	
Benzene	20	28.9	35
Chloroform	20	27.1	32.8
Ether	20	17.0	10.7
Isobutyl alcohol	20	22.8	2.1
Mercury	0	480	
Tin (molten)	400	518	
H ₂ SO ₄ , 98.5%	100	52.5	
C ₂ H ₅ OH, 25% aq.	30	34.1	
NaOH, 200 g./l.	18	82.8	

(From "A Treatise on Physical Chemistry", D. Van Nostrand Co., Inc., New York).

surface, a surface behaves as if it were in a state of tension and this state is, therefore, properly called "surface tension." It is given the symbol γ and may be defined as the force in dynes acting at right angles to any line of 1 cm. length of surface. The work done in extending the area of a surface by 1 sq. cm. is equal to the surface tension, and the surface energy in ergs per sq. cm. is equal to the surface tension in dynes per centimeter. Surface tension is really the net surface effect of the cohesive forces between atoms.

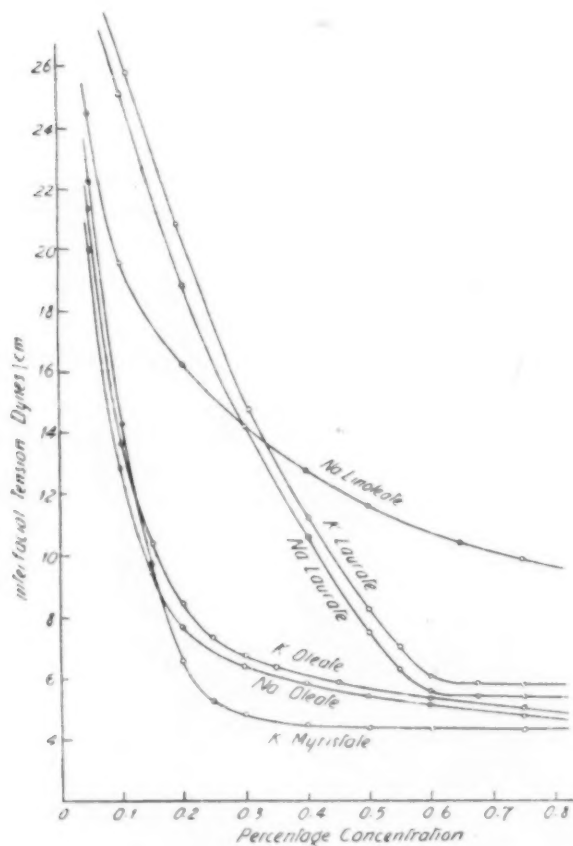


Fig. 2. Interfacial tension—concentration curves for various soap solutions against xylene at 25° C. Note that only very small concentrations are required for maximum effects, and an excess of soap has little more effect⁵.

With the exception of pure hydrogen peroxide, water has the highest surface tension of any known non-metallic pure liquid at normal temperatures. Substances of low boiling point usually have low surface tensions; for metals, inorganic salts, and other high melting point materials, the surface tensions are high. (See Table I.)

Surface tension is usually determined with the surface in contact with air and its own vapor. Tension existing between two solid phases, a solid and a liquid, and two immiscible liquids is called "interfacial tension."

Plating processes are more concerned with interfacial tensions than liquid||air (vapor) tensions. As mentioned previously, interfacial tensions involving solids and solids, and solids and liquids cannot be determined definitely, but a measure of the interfacial tension existing between a liquid and a solid can be indicated by the readiness of "wetting" and the spreading tendency of the liquid on the solid.

Interfacial tensions existing between two immiscible or partly immiscible liquids can be determined by both dynamic and static methods. Methods for determining surface tensions will not be discussed in this article as they have already been discussed by the author¹ in a previous article. According to the Rule of Antonov,² the liquid||liquid interfacial tension is equal to the difference between the two solution vapor tensions. The work of Harkins and Ginsberg,³ however, has definitely disproved this rule. Antonov's Rule is useful, however, in distinguishing between spreading and non-spreading liquids. Typical surface tension curves are shown for soap in Figure 2.

Effect of Temperature on Surface Tension

With rising temperature, the surface tension decreases and becomes zero at the critical temperature of the liquid. Thus cleaning solutions, particularly those without wetting agents, have lower surface tensions when used hot than when used cold, and this lower surface tension is one of the reasons for better detergency of warm solutions than of cold. Also, any liquid dirt to be removed has a lower surface tension when heated, and thus the interfacial tension between the oil and cleaning solution is lower. It will be shown later that low surface tension or interfacial tension is not an indication, necessarily, of good detergency, but low surface tension is a contributing factor to good detergency.

Because of temperature effects on surface tension, all surface tension measurements should be done at definite temperatures.

Substances Affecting Surface Tension

The addition of a third component to one of the liquids forming a mobile interface normally changes the surface tension. When the surface tension is low (20-30 dynes/cm.), most normally surface active materials are inactive.

Among the surface active materials are: organic acids, alcohols, esters, ethers, amines, aldehydes, ketones and terpenes. Among the comparatively inactive surface materials are: inorganic electrolytes, salts of organic acids and bases of small molecular weight, and some difficultly volatile non-electrolytes such as sugar and glycerin. Alkalies do not affect the surface tension more than a few per cent and

TABLE II

Effect of Concentration of Solute on Surface Tension

Substance	Temp. °C	Surface Tension for Concentrations Indicated				
Ethyl alcohol	30	Wt. %	0.98	2.14	10.4	50.0
		S. T.	66.1	61.6	45.9	27.5
Phenol	20	Wt. %	0.024	0.47	1.88	5.62
		S. T.	72.6	66.5	54.0	42.3
Acetic acid	30	Wt. %	1.00	5.00	30.1	70.0
		S. T.	68.0	60.1	43.6	34.3
Sugar (sucrose)	25	Wt. %	10.0	20.0	30.0	40.0
		S. T.	72.5	73.0	73.4	74.1

(From "A Treatise on Physical Chemistry", D. Van Nostrand Co., Inc., New York).

usually they raise the surface tension rather than lowering it.

Substances that lower surface tension are heteropolar in that they contain a polar or water-soluble portion, and a non-polar or oil-soluble portion. The polar-nonpolar relationship will be discussed later.

When two liquids whose surface tensions do not differ very greatly are mixed, the surface tension of the mixture is roughly a linear function of the concentration. If the surface tensions of the component liquids differ appreciably, however, then the addition of very small amounts of the liquid of lower surface tension, results in a marked decrease in the surface tension of the solution mixture. (See Table II.) The reason for this is that any substance capable of lowering surface tension tends to accumulate at the interface. This is a result of the tendency of the free energy of a surface to decrease, and the concentration of the component with lower surface tension at the surface reduces the free energy of the surface. It follows that if the particular solute lowers the surface tension, it will be present in greater concentration at the interface than in the body of the liquid. Thus the foam on alkaline cleaners is higher in soap or wetting agent than the body of the solution and foam on beer is higher in alcohol than the liquid beer.

If the solute brings about an increase in surface tension, then its concentration at the surface will be less than in the body of the solution. This is the case for caustic soda dissolved in water.

Oriented Structure At Interfaces

We have indicated previously that surface active materials are of heteropolar nature possessing a polar or water-soluble portion of the molecule, and an oil-soluble or non-polar portion. The polar portions or groups are called such because they confer upon the molecules containing them, a characteristic permanent electric moment which reveals itself in dielectric phenomena and which probably determines the nature of intermolecular forces. Quantitatively, the polar effects vary with the type of structure of the polar compound and on the specific chemical properties of the liquids or substances with which the polar group is in contact. The order of affinities of active groups for water, for derivatives of an aliphatic hydrocarbon are: saturated paraffin < unsaturated paraffin < halides, nitrates < esters, ethers, ketones < aldehyde, amine, alcohol < acid. Compounds made up of any two or more of these groups would be heteropolar although the degree of "heteropolarity" when composed of near or adjacent groups would be slight. We will see later that all of the commercial wetting agents or surface active

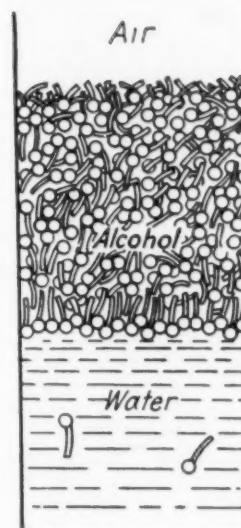


Fig. 3. Structures of the interfaces butyl alcohol||water and butyl alcohol||air according to the orientation theory. The circle and tail represent the OH-group and the hydrocarbon chain, respectively.

(From "A Treatise on Physical Chemistry", D. Van Nostrand Co., Inc., New York).

materials are of organic non-polar groups with one of the above or allied polar groups.

The polar portions have a greater affinity for: water, metals, and inorganic salts than do the non-polar groups, and the latter groups have stronger affinities for: organic materials such as oils, and air. Figure 3 illustrates the orientation of heteropolar butyl alcohol which is only slightly soluble in water.

A numerical comparison of the activities of the polar and non-polar groups of a molecule may be obtained by taking the difference between the adhesional energy toward water, W_a , and the cohesive energy, W_c . This is shown in Table III and it may be seen that the surface activity ($W_a - W_c$) is relatively large for acid and alcohol groupings but is weak for essentially non-polar hydrocarbons.

When a surface active material is added to water, the material collects at the surface in higher concentration than in the solution, and the surface active molecules orient themselves so that their polar portions or groups are buried in the water and the non-polar portions project out of the water. The depth of burial of the polar groups and the degree that the non-polar portions are dragged into the water, would depend upon the relative water and oil solubilities of the two

TABLE III
Relative Surface Activities of Various Heteropolar and Non-Polar Compounds

Substance	Adhesional Energy W_a in Ergs	Cohesional Energy W_c in Ergs	Surface Activity $W_a - W_c$ in Ergs
Isopentane	36.9	27.4	9.5
Isoamyl chloride	69.2	54.4	14.8
Isoamyl chloride	80.8	47.0	33.8
Isoamyl alcohol	92.5	47.6	44.9
Isovaleric acid	94.6	50.7	43.9

(From "A Treatise on Physical Chemistry", D. Van Nostrand Co., Inc., New York).

TABLE IV
Cross-Sections and Lengths of Molecules as Estimated by Langmuir⁴

Material	No. of Carbon Atoms per Molecule	Film Thickness	Area per Molecule
Palmitic acid	16	24 Å	21 sq. Å
Stearic acid	18	25	22
Cerotic acid	26	31	25
Myricyl alcohol	31	41	27

(From "A Treatise on Physical Chemistry", D. Van Nostrand Co., Inc., New York).

groups and on their size. If the water solution is in contact with oil or material less polar than water (and there are very few liquids more polar than water), the non-polar portion of the surface active material is buried in the organic solvent or oil.

This orientation is an important factor in detergency and, for example, when oil is washed off work with a soap solution, the oil droplets are prevented from forming a new oil film and sticking on the work by the protective film of oriented soap molecules around each droplet of oil as illustrated in Figure 4.

From the data of Langmuir⁴ shown in Table IV, it will be noted that when long-chain molecules of fatty acids are placed upon water, the film thickness increases with an increase in the number of carbon atoms in the chain, but the area of surface covered by the molecules is relatively constant. This indicates that the molecules are oriented with their long chains perpendicular to the surface of the water, and the film thickness is really a measure of the length of molecule, and the film width is a measure of the cross sectional area of the molecule. X-ray data and new measurements on cross-sectional area of molecules indicate that the non-polar portion of the surface active material is oriented at an angle as indicated in Figure 5.

Wetting and Dispersing

In addition to wetting ability, a detergent must possess

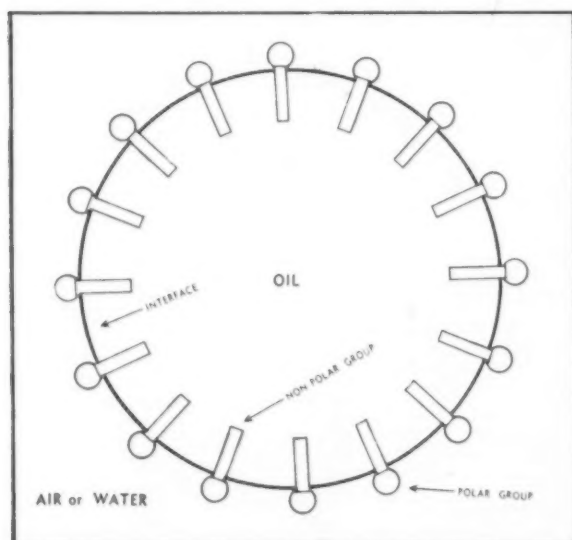


Fig. 4. Drawing illustrating the orientation of polar-nonpolar substances at the interface of an oil drop dispersed in water. These oriented molecules exert a protective action preventing agglomeration.

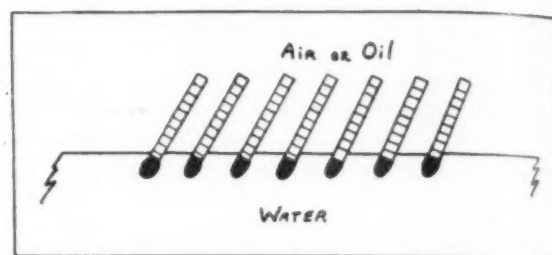


Fig. 5. Diagrammatic sketch illustrating the angle orientation of polar-nonpolar substances at water and air or oil interface. Forces existent between molecules prevent contact between the molecules.

dispersing power, which is the ability to separate and keep dispersed or suspended, solid particles which are insoluble in the cleaning medium. Surface tension depressants may be poor dispersing agents. This can be shown by the following experiment: Add carbon black to a dilute solution of a wetting agent and it will be noticed that the carbon black is readily wetted but after being shaken, the carbon soon settles out. That is, the carbon is not properly dispersed or suspended and can re-deposit upon the work. If a true dispersing agent is added, the solution gets darker from the increased amount of carbon in suspension and a much greater time is required for the settling of the carbon.

Dispersing agents are materials that overcome the adhesive forces between solid particles, and in addition, prevent these adhesive forces from reacting to cause agglomeration of the particles again. Dispersing agents are specific for the solid to be dispersed and frequently for the solute. Sodium silicate, for example, has little effect on surface tension, yet it is an excellent dispersing agent for many types

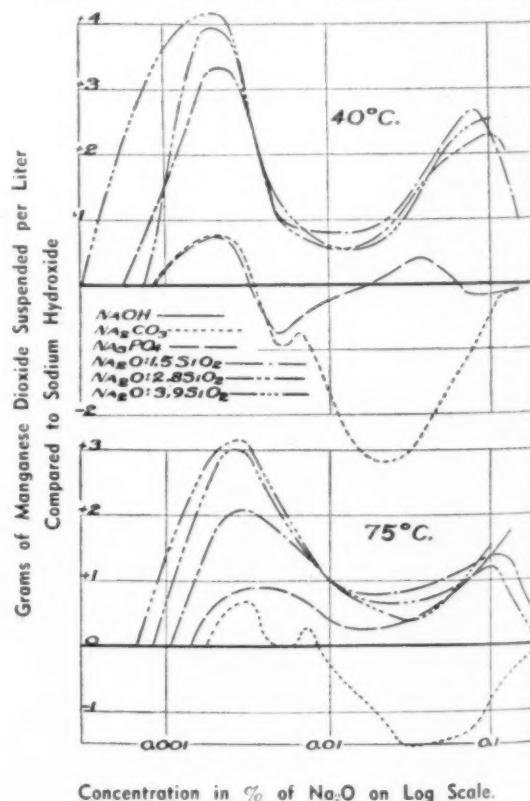


Fig. 6. Curves illustrating deflocculating action or suspending power on manganese dioxide by unit amounts of sodium oxide in various concentrations as furnished by different alkalis. The base line is that of sodium hydroxide⁶.

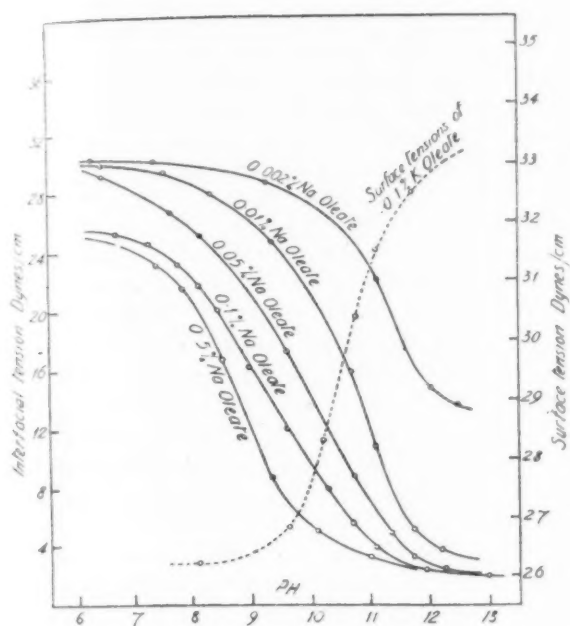


Fig. 7. Curves illustrating the effects of pH on interfacial surface tensions against xylene of various concentrations of sodium oleate⁵. Note that pH has a marked effect, with maximum effects at pH's above 11.

of solid particles. Caustic soda is a poor dispersing agent. The ability to disperse is probably associated with the formation of an adsorbed film greater than those formed by many wetting agents and probably also with an electrostatic effect. It is possible that a material can be a good wetting agent and a good dispersing agent, but a good dispersing agent may be a poor wetting agent. Figure 6 illustrates the relative dispersing power of alkalis.

Types of Wetting Agents

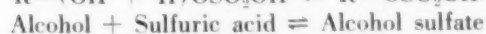
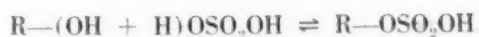
Soap:

Up to a comparatively short time ago, the only wetting agents that were available for plating purposes were the soaps. Soaps possess several inherent disadvantages, among which are: Poor rinsing, low solubility in cold water, stable foam, precipitation with calcium, magnesium or heavy metals, hydrolysis to give pH's from 10.0 to 10.5, neutralization with acid to precipitate the fatty acid, and salting out. All of these disadvantages are real and have mitigated against the use of soap in the plating room. Specific troubles from each disadvantage could be mentioned, but it is believed that they are sufficiently well known to omit their enumeration. The effects of pH on the surface tension of soap solutions are shown in Figure 7.

Sulphonated castor and corn oils were available but these materials have relatively poor wetting and detergent powers. Their chief use was in the so-called "solvent soaps" but even in this use, they are being displaced by naphthenic soaps and other products.

Alcohol Sulfates:

The first synthetic wetting agents were made in Germany and were true sulfates of fatty acids, and not sulfonates. The sulfates are formed by a process akin to esterification. Sulfation consists of reacting sulfuric acid with an alcohol according to the following equation:



R = fatty alcohol radical such as lauryl, myristal, etc.

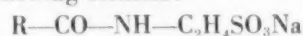
The alcohol acid esters are then treated with caustic soda to give their sodium salts as follows:



It is obvious that there are many possible wetting agents of this type, as there is an almost unlimited number of straight chain and branched chain aliphatic hydrocarbons. However, the number of wetting agents usable is limited by the solubility of the fatty alcohol sulfates and by an economic factor—cost.

Sulfonated Amides:

This type of capillary active material is characterized by a long non-polar group which is relatively narrow as illustrated by the following formula:



where R is an alkyl group. This type of compound is anionic and acts similarly to the fatty acid sulfates in regard to wetting and detergency but they are not as stable, as a class, to alkalis and strong acids.

Sulfonated Alkyl-Aryl Compounds:

This is a very extensive group of wetting agents which are characterized structurally by a sodium sulfonate group attached to an alkyl substituted aryl grouping such as benzene and naphthalene. The alkyl groups may be methyl, ethyl, propyl, butyl, etc. The surface tension depressing abilities of this class of compound are relatively greater than the alcohol sulfates or sulfonated amides and they give less stable foam and generally slightly poorer detergency. The materials are anionic.

Esters of Sulfonated Dibasic Acids:

This class of capillary active materials is very comprehensive and the compounds are generally excellent surface tension depressants which give less stable foam than the alcohol sulfates. A typical wetting agent of this type is the sodium salt of the dioctyl ester of sulfonated succinic acid.

Salts of Alkyl Phosphoric Acid Derivatives:

This type of surface active material is essentially neutral in reaction and they are good wetting agents. They are precipitated by calcium but the precipitates, however, are dispersed by an excess of wetting agent. Some of the wetting agents of this class are uniquely non-foaming which may, on the surface, appear contradictory in view of their being wetting agents. However, the lack of or small degree of foaming may be explained by the fact that a small amount of alkyl alcohol such as octyl alcohol is liberated from them, and the insoluble alcohol acts as a de-foamer. Hexyl and octyl alcohols are used to some extent as de-foamers but it must be understood that the de-foaming of the wetting agent solutions is a relative and not an absolute term.

High Molecular Weight Alcohols:

By proper selection of hydrocarbon groupings, it is possible to make a heteropolar, moderately soluble alcohol that possesses capillary active properties. Because of the absence of sulfate, sulfonate, amine, carboxyl or phosphate groupings, this type of compound is completely non-ionic which

enables the mixing of it with ionic wetting agents. The class is relatively stable to oxidizing agents and has high tolerance to salts.

Relation Between Wetting Power and Molecular Structure

We have briefly considered various types of wetting agents or capillary active materials, and we may be led to inquire whether there is a relationship between structure and such properties as solubility, wetting power, foaming, etc. It has been mentioned previously that surface active materials orient themselves at interfaces with the polar portions of the molecules in the water or inorganic phase, and the non-polar portion in the oil or organic phase. We have also shown how surface active materials tend to accumulate at the surface in concentration greater than in the body of the solution.

It is obvious that the orienting forces are related to the size of the polar and non-polar portions of the molecule and the specific structure of the molecule. In addition, from purely mechanical considerations, molecules with narrow non-polar portions should pack more closely than broad molecules, and on a weight basis, the more complex molecules should be better surface depressants than the compounds with long, narrow molecules. Thus we would expect that the relative wetting ability of an alkyl, aryl sodium sulfonate would be better than a fatty alcohol sulfate, and a compound with the polar grouping in the middle, such as in the case of the dioctyl ester of sulfonated succinic acid, the wetting ability should be better than the alkyl, aryl sodium sulfonate. This is graphically shown in Figure 8.

To illustrate the effects of changing the character of the non-polar portion of the molecule, it has been observed, for example, that the dilauryl ester of the above-mentioned dibasic acid is practically insoluble and worthless as a

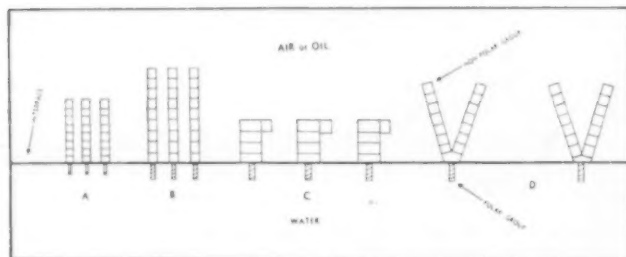


Fig. 8. Diagrammatic sketches illustrating the surface covering power of various types of surface tension depressants. Illustrated at A are the molecules of sulfated aliphatic alcohols. It should be noted that they pack relatively closely and do not cover much area. In B are illustrated the atoms of the sodium salt of sulfonated amides. The widths of these molecules and the covering power are similar to A, although the molecules may be longer.

In C are illustrated sulfonated alkyl-aryl molecules which are relatively broad and short. Hence, their covering power is greater than either A or B, but the detergency of this type of material may be less than either A or B.

In D are illustrated the orientation of complex compounds containing the polar group in the middle of a long non-polar group, or the polar group is attached to two non-polar groups. This class of material includes very active surface tension depressants, although their detergency characteristics may be poorer than A or B type materials.

wetting agent. As the length of the polar chain is decreased, the solubility of the dibasic acid ester increases, with a decrease in wetting power. The dibutyl ester has practically no wetting power in water at a concentration of 1% but it possesses considerable wetting power in 20% sodium sulfate solution. This illustrates an important point to remember in regard to wetting agents, namely, that *the wetting power of a wetting agent is influenced by the degree of solubility and the concentration of other materials in solution with the wetting agent*. The effects of sodium chloride on the wetting powers of a surface active material are shown in Figure 9.

A corollary of the above is that *a surface active material must not be either insoluble or too soluble*. If it is only slightly soluble, then there will not be sufficient material in solution and at the interface to affect the surface tension, and if it is too soluble, then the polar-non-polar relation is either non-existent or too weak to give an oriented structure at the interface.

It should also be obvious that surface active materials are relatively difficult to rinse, and the ability to be rinsed is dependent upon the solubility of the wetting agent and on the specific structure of the wetting agent. Also, wetting agents will vary markedly in their ability to be rinsed and strongly surface active materials will be harder to rinse off metals than weakly surface active materials. The rinsing ability will also be dependent on the specific type of polar grouping contained in the molecule. It follows that if plating solutions, or cleaning solutions containing surface active materials, are filtered through strongly adsorptive substances such as activated carbon, they will be largely removed.

Foaming

A characteristic of surface active materials is foaming, and the conditions requisite for surface tension depressing are similar to those for foaming, namely that a difference of concentration of the surface active material exists between the surface and body of the liquid. It may be stated generally that detergent type materials are better foam producers than strictly wetting type and relatively poorly detergent type materials. This is particularly unfortunate for metal cleaning where agitation is used, such as in spray washing or where gas is evolved such as in electrocleaning.

In these cases, the removal of the surface active material may seriously affect the cleaning qualities of the alkaline cleaner. Insoluble polar materials such as hexyl, octyl and decyl alcohols have a limited tendency to break the foam without greatly affecting the detergent qualities of the solution. However, they have the disadvantages of being relatively volatile at the operating temperature of electrocleaners and they tend to adhere to the metal and be dragged out of the solution.

Figure 10 illustrates schematically the orientation occurring in a film of a bubble or foam. The relative stability results from a degree of "buffering" of forces existent at the surface. Thus if the tension in the film is increased by increasing the surface area, the concentration of wetting agent in the surface is reduced and the increased surface tension balances the increased tension applied. On the other hand, if the area is reduced, then the concentration of wetting agent in the surface is increased, and the surface tension is decreased to balance the reduced tension.

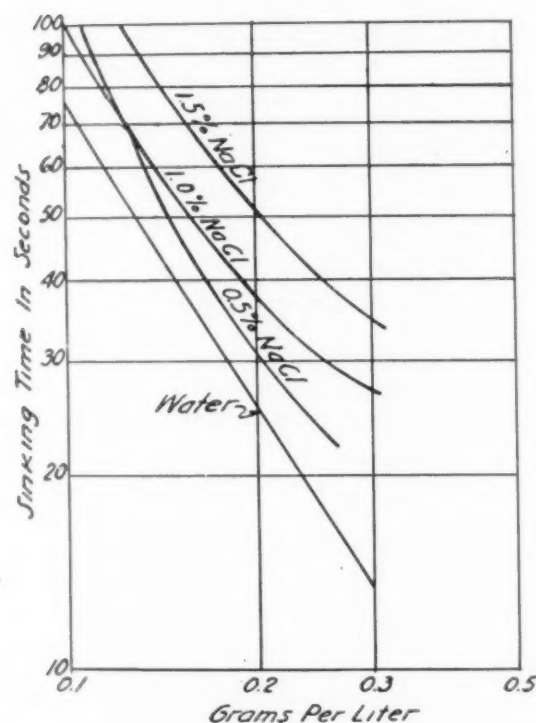
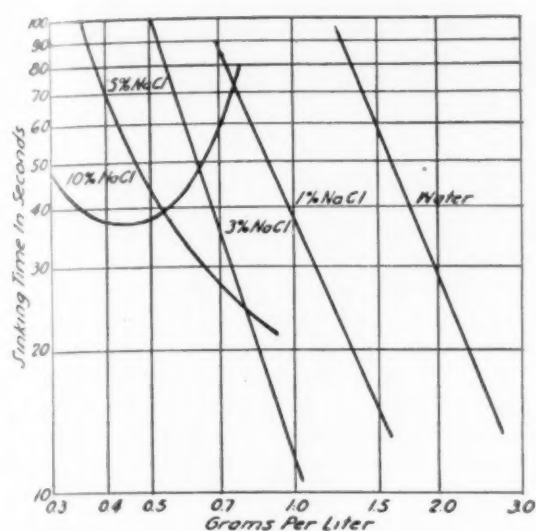
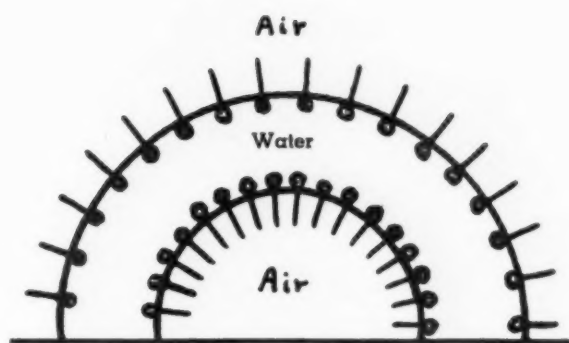


Fig. 9. Curves illustrating the effects of sodium chloride on two types of wetting agents. The upper curves show the effects of various concentrations of salt on the wetting power of the sodium salt of sulfonated dihexyl ester of succinic acid. It will be noted that salt increases the wetting power of this wetting agent.

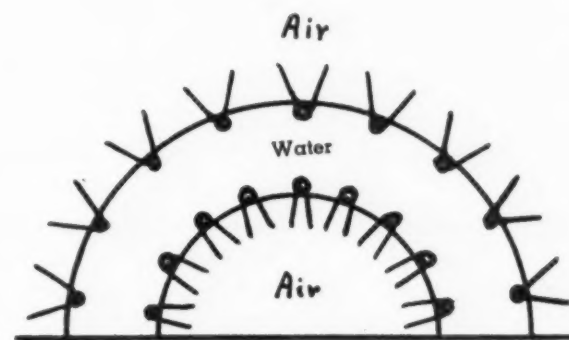
The lower group of curves shows the effects of salt on the dioctyl ester of the sodium sulfonate of succinic acid. In this case, the wetting power is decreased by the sodium chloride. The above effects are probably due to changes in the solubility of the wetting agent by the sodium chloride in solution.

The Draves test consists of measuring the time necessary for a 5-gram skein of unboiled two-ply cotton yarn to sink in a definite concentration of a wetting agent in water at a definite temperature.

It is obvious, therefore, that materials inducing foam should not be too soluble or insoluble. If they are too soluble, then the polar-non-polar relationship is deranged



A



B

Fig. 10. The above drawings illustrate the orientation of surface active materials at the interfaces of foam. In A is illustrated the relatively denser packing of molecules of the alcohol sulfate type in contrast with the less dense packing of the molecules, as shown at B, for example, for compounds containing the polar grouping in the middle of a long non-polar grouping.

so that the difference in concentration of material between the surface and body of the liquid cannot exist, or if it does, it is only weakly existent. If the material is not sufficiently soluble, then there will not be sufficient molecules at the interface to affect the surface tension.

Harder foams result with detergent type materials with long, narrow, non-polar chains such as the fatty alcohol sulfates because they can pack more densely and closely than the branched chain or broad non-polar groupings.

Detergency

It should be emphasized again, that surface tension depressants may not necessarily be good detergents, and it is likely that the most highly capillary active materials are the poorer detergents. Soap is about the best detergent available and failure to use soaps more generally in metal cleaning is not due to poor detergency, but due to other factors previously mentioned such as precipitation with calcium or metals, foaming, poor rinsing, etc. Soap and other good detergent materials possess the power to lower surface tension, but, in addition, have other properties such as the ability to deflocculate and the ability to form a relatively stable foam. As a general class, good detergent surface active materials are characterized by relatively simple, long chain, non-polar groupings with powerful polar

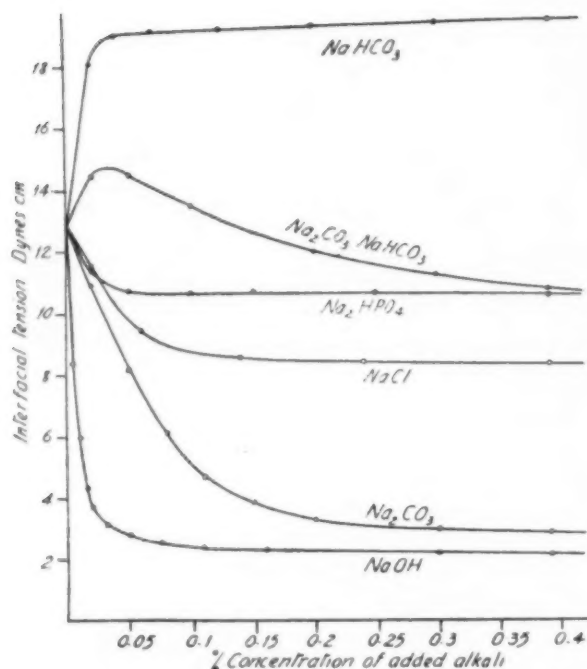


Fig. 11. Curves illustrating the effects of added alkalis and salts on the interfacial tension of 0.1% sodium oleate solutions against xylene. Note that small concentrations have a relatively large effect, but for higher concentrations, the effects remain relatively constant.

groupings such as the carboxyl grouping (sodium salt). The effects of alkalis on the surface tensions of soap solutions are shown in Figure 11.

The detergent ability of surface active materials is greatly affected by the presence of other materials in the solution which may affect the pH, and favor deflocculation (silicates). Some of the reasons for this have been already discussed. Another reason not mentioned, is the fact that the soil to be removed may bear an electrical charge, and if it is possible, it is advisable to make the surface have the same charge as the soil so that they will repel one another.

Ionic Nature of Surface Active Materials

Most of the surface active materials ionize to some extent to give positively and negatively charged particles. Materials such as the fatty alcohol sulfates, the sodium sulfonates of alkyl, aryl compounds and the dibasic acid sodium sulfonates are anionic materials so-called because the organic portion of the molecule migrates to the anode when a D. C. current is applied to the solution.

The cationic type wetting agents are much less frequently used than the anionic type materials. Some cationic type materials are the primary and secondary amine acid salts, quaternary ammonium compounds and sulfonium and phosphonium compounds. It follows that if a cationic and an anionic material are mixed, then a precipitation of the wetting agents may result because a large insoluble molecule may form. It is also evident that wetting agents may behave differently depending upon whether they are intended to work at the anode or cathode. Thus the effects of an anionic material would be greater at the anode (anodic cleaning), and the cationic material greater at the cathode (cathodic cleaning). It is also possible for example, for anionic materials to be precipitated at the anode by neutralization

of the charge on the non-polar ion and particularly when the acid or sulfonic acid are insoluble and convection is poor.

Mention has already been made of materials that are non-ionic which are not affected by an electric current, and they usually can be used safely with ionic materials.

Calcium Precipitation

Wetting agents are vastly superior to soaps in their ability to resist precipitation by calcium, magnesium and heavy metals. Wetting agents vary greatly in the concentration of calcium that they will withstand. The tolerance is dependent on the molecular weight of the compound, its specific structure and the concentration of the wetting agent. Thus, for example, one wetting agent will withstand 540 parts per million of calcium (calculated as calcium carbonate) when the wetting agent is in concentration of 0.50%, and when in concentration of 0.025%, will withstand 860 parts per million of calcium. Another wetting agent is not precipitated by calcium in concentration of 200 grains hard. Usually where precipitation does occur, an excess of wetting agent will cause a dispersion of the precipitate.

Conclusion

In summation, some of the factors to be considered in selecting a wetting agent for any particular use are:

1. Effect on surface tension
2. Detergency
3. Foaming
4. Resistance to precipitation by salts, heavy metals, calcium
5. Effect of electrolytes on wetting agent used
6. Degree of foaming
7. Resistance to oxidation, hydrolysis, reduction
8. Ionic nature
9. Rinsing ability
10. Cost

Undue emphasis cannot be placed on the statement that each job requires a specific type of wetting agent and that all wetting agents are not alike but possess specific properties. For example, one wetting agent may be satisfactory for nickel plating solutions at one plant but could be unsuitable at another due to differences in pH, hardness of water and current density used. The writer hopes to discuss specific applications of wetting agents in a later paper.

He has attempted to explain the principles of the phenomenon of surface tension and to describe the various factors which must be evaluated in selecting a surface active material. It is hoped that the principles discussed will enable a clearer picture of this subject to be obtained by the reader. There are many other factors which might be considered but it is hoped that the major ones have not been overlooked.

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Brightening Electro-tin Deposits

BY GARSON A. LUTZ

Research Laboratory,
Blaw-Knox Co.,
Blawnox, Pa.

PRI-MARY requisites of an electroplating bath, include its inherent ability to give an adherent, fine grained, and uniformly distributed deposit. More recently, formation of bright metallic deposits has in many cases been a distinct asset. Formation of bright deposits frequently is attained only indirectly, i.e. treatment of the deposit with a brightening agent (a selective pickle), either by an immersion or by an electrolytic method.

Fusion Process

In the following discussion, the author describes a brightening process as applied in improving the reflectivity of electro-tin deposits. A general procedure to obtain bright electro-tin deposits on steel surfaces consists in properly washing and drying the matte electro-tin deposit, and then heating the same above its fusion point. A satisfactory three step process in which the electro-tin deposit is gradually heated to a temperature below the fusion point of tin, then quickly above it, and finally cooled to a temperature where no immediate transition occurs, describes the cycle. Mineral oils which have flash points well beyond the fusion temperature attained, and which polymerize or decompose slowly with minimum changes in acidity and viscosity, are satisfactory.

In order to obtain a uniform lustre of the tin surface, it is necessary to add vegetable oils to the fusion bath. Commercially, the use of palm oil offers many advantages. However, the use of a compounded oil bath for fusion purposes results in numerous difficulties. Volatility and instability of palm oil under conditions of operation, and subsequent alterations in acidity and viscosity of the fusion bath, are prevalent complications. Thus the frequent replenishment of the fusion bath with palm oil is necessary, a factor which is difficult to control quantitatively.

In order to avoid the use of vegetable oil as a fusion medium, the following investigation was performed. The chemical property of palm oil as a brightener, singularly, or compounded, was recognized. As such, it functioned best under pyrolytic conditions. Frequently, however, the resulting tin surface was etched, the etching no doubt being a degree of brightening. This might indicate that monocarboxylic acids of high molecular weight or decomposition products of the same (aldehydes, ketones, acids) were instrumental in promoting reflectivity. The problem consequently resolved itself into a search for the proper acid or acid medium, and the proper reducing agent or agents.

Experimental

Early investigations revealed that water soluble saturated mono- or dibasic acids possessed brightening properties. However, the degree of brightening upon subsequent treatment in the three step mineral oil process was less intense than if palm oil were added to the fusion bath. Water soluble ketones, alcohols and aldehydes, possessed little, if any, brightening properties. Upon investigating polybasic acids, it was found that citric acid (5%-10% hot aqueous solution) showed satisfactory brightening properties. Tin samples immersed 10-15 seconds in the latter solution, followed by washing, drying and subsequent melting in the three step mineral oil process compared favorably, both in reflectivity and also porosity tests, with palm oil—mineral oil specimens. The use of 1%-2% stannous chloride in the citric acid solution decreased the time of treatment to five or ten seconds. This observation again indicated that reducing agents were preponderant in accelerating the brightening action.

Extensive investigation of reducing agents proved this observation. Two closely related compounds, hydrazine hydrochloride and guanidine hydrochloride are both satisfactory in promoting and maintaining brightening action when added to citric acid and stannous chloride solution. The time required for brightening, making use of palm oil in the fusion bath unnecessary, is two to five seconds.

Brightening Treatment

Composition of an aqueous solution giving satisfactory brightening is as follows:

	g/L
Citric acid	50-100
Stannous chloride	20- 30
Hydrazine hydrochloride	20- 30

In place of hydrazine hydrochloride, an equal or slightly higher percentage of guanidine hydrochloride can be substituted. The pH of either of these solutions is approximately 1. Temperature of operation is 200° F. or slightly higher. In this brightening process, loss of tin is negligible, the fusion product is extremely bright and porosity tests compare favorably with tests made on palm oil-mineral oil specimens.

Anodizing of Aluminum[†]

BY E. R. HOLMAN

Senior Chemist
Turco Products, Inc.,
Los Angeles, Cal.

The author compares the operating features of the sulfuric acid and chromic acid anodizing solutions. Properties of the coatings as well as equipment required are also discussed. The chromic acid process is discussed in detail.—Ed.

THE anodizing of aluminum is a process for building up an oxide coating on the metal by electrolysis in which the work is made the anode. This is contrary to most commercial electroplating as the plater normally regards the oxides as something to avoid or to get rid of rather than something to cultivate.

It is the development of the anodizing process that has helped to make possible the widespread use of aluminum in aircraft. The anodic film is the answer for passivating this highly reactive—this easily corroded metal—aluminum, and rendering its surface suitable for a coat of paint with excellent adhesion.¹

Considerable fine work has been done in the way of finding out the exact chemical composition of the anodic film. X-ray studies have yielded inconclusive results in most cases; however, a few investigators have reported that the film is aluminum oxide in the gamma form.²

It is surprising to find that very little has been written about anodizing in a chromic acid electrolyte, although this is the oldest commercially applied process. The sulphuric acid process is tightly bound up in the Alumilite patents now held by the Aluminum Company of America.

Henry A. Smith of Toronto, Canada, read a paper before the Buffalo Branch on November 10, 1939, in which he described the Alumilite process employing a sulphuric acid electrolyte. This paper was written up in *The Monthly Review of the A. E. S.*, November, 1939, issue. I will draw on his paper for information on the sulphuric acid process and compare it with the chromic acid process which is more pertinent to production for aircraft protection.

Applications of the Two Processes

The foregoing table compares the patented Alumilite process with the commonly applied chromic acid process. The chromic acid process is applied exclusively for purposes of corrosion prevention, while the Alumilite process is applied for ornamental purposes, for abrasion resistance or for corrosion prevention purposes. Any of these features can be brought out in varying degrees in the sulphuric acid process by the proper regulation of the composition or of the temperature of the electrolyte, or of the voltage across the

tank. The chromic acid process is not so variable, hence is comparatively foolproof when compared with the sulphuric acid process.

Limitations of the Two Processes

For purposes of corrosion prevention and for paint adhesion, both the Army and the Navy recognize the value of the film that is produced by the chromic acid process and rate it on an equal basis with the protection offered by the patented Alumilite process.³ For aluminum alloys containing more than 5% of copper, the chromic acid process is not allowed.^{4, 5} All of the sheet aluminum alloys which are commonly used in aircraft, including Duralumin, fall well within this limitation. These are for the most part the alloys designated by the numbers 17ST and 24ST, and their alclad sandwiches designated by the numbers ALC17ST and ALC24ST, respectively. These alclad sheets are seldom, if ever, anodized and seldom, if ever, painted excepting for the insignia or camouflage. Anodic films produced in the sulphuric acid electrolyte are not allowed by the Army or Navy on assembled parts which are subject to stress and which contain joints or recesses in which the anodizing solution may be retained.^{5, 6}

Some Advantages of the Alumilite Process

For purposes of ornamental aluminum or aluminum reflectors, the chromic acid process cannot compete with the sulphuric process. According to the Alumilite process, the work as it leaves the electrolyte carries a highly absorptive film which draws various dyes and chemicals until it is sealed by heating in the second rinse tank (180-210° F.). This property enables the plater to apply variously colored durable finishes to aluminum articles with the technique of masking and then dipping into staining vats before sealing. Certain dyes, notably the basic dyes, are not absorbed in the oxide coating unless a mordant is absorbed in the oxide first.² The film can also be colored with inorganic pigments by dipping into two mutually reactive solutions in succession so that the insoluble pigment forms within the film itself. Chrome yellow, which is lead chromate, can be deposited in this manner, as well as a jet black composed of cobalt sulfide, or a deep blue composed of Prussian blue. If the film is treated with photo-sensitive chemicals, it is possible to reproduce photographs from negatives.

[†]PRESENTED TO THE LOS ANGELES BRANCH, A.E.S., JAN., 1941.

The Salt Spray Test

That the chromic acid process is simpler and more easily controlled is evident from the comparison chart given below. The Army and Navy leave the choice of the process up to the contractor but require that the film perform satisfactorily under the salt spray test.^{3 4 5} Test specimens^{6 7} are exposed to a 20% salt spray at 95° F. for 30 days. If there is evidence of corrosive attack at this time, the specimen is given tensile tests. A reduction in tensile strength of 5% or a reduction in elongation of 10% shows that the work is not acceptable.³

CHROMIC ACID PROCESS

Chemical Control of the Electrolyte

The electrolyte for the chromic acid process carries 5-10% of chromic acid⁸, or 6.7-13.4 oz./gal. Two impurities must be watched: (1) chlorides not to exceed 0.02% as NaCl, and (2) sulphates not to exceed 0.05% as H₂SO₄. This permits the use of technical grades of chromic acid of 99.5% purity. For example, chromic acid in granular or flake form of the following composition has been found satisfactory:

Chromic acid (CrO ₃)	99.5%	minimum
Sulphates (SO ₄)	0.10%	maximum
Chlorides (Cl)	0.05%	"
Insoluble matter	0.10%	"

This grade is commonly used in chromium plating. It is necessary to check the water used in this process as in some localities the chloride content of the tap water is such that the above specified tolerance is exceeded. The practical significance of this is best borne out by the following example: Aircraft Company A and Aircraft Company B are located across the street from each other. In spite of this proximity, they lie in different municipalities and therefore have different sources of water supply. The tap water supplied to Aircraft Company A is sufficiently pure to permit its use in making up the anodic bath and in maintaining the level of the solution. Aircraft Company B is less fortunate in that the chloride and sulphate contents in its tap water are high. When due allowance is made for the building up of chlorides and sulphates resulting from constant replenishment of water that is lost by evaporation and electrolysis, this tap water is found to be unsatisfactory. Therefore, Company B is compelled to employ distilled water for the electrolyte, whereas Company A is permitted to use tap water.

Temperature

The temperature of the electrolyte is very important but not as critical, apparently, as in the case of the sulphuric process. For the chromic acid process, the temperature must be held to 95° F. with a permissible fluctuation of 4° F. above and 4° F. below that figure. Automatic temperature control is very desirable but is not required. A recording thermometer is required on Navy specifications. A combination recording and regulating thermometer is available from several sources.* Both heating and cooling facilities are required. Heating is required only when the tank has been idle for some time. Cooling is accomplished by running tap water through coils in the sides or ends of the tank. This tap water runs out into the rinse tanks which

*Names furnished on request.—Ed.

Comparison of Alumilite and Chromic Acid Processes of Anodizing

	ALUMILITE	CHROMIC ACID
ELECTROLYTE:	Sulphuric acid and water	Chromic acid and water
CONCENTRATION:	Depends on desired result: (1) clear color and high durability, (2) Colored for decorative value, (3) flexibility for cold working	5-10%
VOLTAGE:	12-24 v. depending on concentration	40 v.
TIME:	Not specified	5-7 mins. for 0-40 v. 30 mins. at 40 v.
CURRENT DENSITY:	12-13 amps./sq. ft.	1½-2 amps./sq. ft.
TEMPERATURE:	68-85° depending on results desired	95° F.
TEMPERATURE REGULATION:	±1° F.	±4° F.
TANK MATERIAL:	Lead lined	Steel plate for batting for insulation
TANK WIDTH:	3 times largest article treated, or 12" clearance all around	Sufficient for work to clear
RINSE:	One cold water rinse, one hot water rinse* (180-210° F.) *wooden tank with stainless steel steam coil	One hot water rinse (120-160° F.), steel tank, gas fired O.K., chromic acid stains are not undesirable
THERMO-REGULATOR AND RECORDER:	Required	Required
RECORDING VOLTMETER:	Required	Required
FILM THICKNESS:	0.0004" in ½ hr. 0.0008" in 1 hr. with: 15% H ₂ SO ₄ 12 amps./sq. ft., 70° F.	Considerably thinner
ANODE CURRENT EFFICIENCY:	Apparent: 69% Actual: 100% plus	Apparent: probably higher as oxide is not so readily soluble in electrolyte
RACKS:	Aluminum only 2S draws 15.6 amps./sq. ft. 17S draws 12.6 amps./sq. ft. and is therefore better	Aluminum only

	Alumi-Lite	Chromic Acid
INTRICATE OR POROUS CASTINGS:	Treatment not allowed if electrolyte cannot be completely rinsed out	Treatment allowed
SEALING:	Separate operation (hot rinse with or without added chemicals)	No separate operation required
THROWING POWER:	No comment	Exceedingly good
COLOR OF COATING:	Light, transparent	Greenish-grey
ABSORPTION OF STAINS:	Highly absorptive in the unsealed condition (amorphous aluminum oxide). Absorptive powers disappear after sealing (aluminum oxide monohydrate $Al_2O_3 \cdot H_2O$)	Non-absorptive
ELECTRICAL CONDUCTIVITY:	Fairly good in unsealed condition; good insulator after sealing	Non-conductive

are further heated up to 150-185° F. The cooling coils must be amply large because considerable heat is generated in the anodizing process and this must be dissipated through the coils.

If you want to visualize what this amounts to, consider, for example, the incendiary bombs which are being used so effectively in the present war. They are made up of the old familiar Thermite formula which is a mixture of iron oxide and aluminum powder. When this mixture is ignited, the aluminum steals the oxygen from the iron and thereby converts itself to the oxide. The intensity of the heat is very spectacular, as newspaper headlines will testify.

In anodizing, the oxidation proceeds under slower, well regulated conditions, but this heat must nevertheless be dissipated. Thorough agitation of the electrolyte is required in order to prevent local overheating. This agitation is provided by bubbling air from a perforated pipe into the bottom of the tank. Too much air must be avoided or else the work being anodized will wave in the solution and may short circuit with the tank (cathode). Again, the anode may work loose and make poor contact, with correspondingly high resistance. When this happens the hooks will burn holes through the work and the job is rejected.

To avoid short circuiting of the work with the sides of the tank, the tank is lined with a picket fence of fir batting. All metal parts exposed to the electrolyte are of steel. No copper bearing alloys are permitted to be dipped into the electrolyte. Only aluminum hooks can be used. If these are to be used again, the contact point must be filed free from oxide because the anodic film is a good insulator. The anodic film can be stripped off from these hooks by chemical dips such as caustic soda etch followed by a 1:1 nitric acid bright dip. The two operations can be combined in one by adding Nitrobrite* to the 1:1 nitric acid solution at the rate of one ounce per gallon. Nitric acid alone will not strip the film satisfactorily.

*NITROBRITE—TRADE MARK REGISTERED, TURCO PRODUCTS, INC., LOS ANGELES.

Voltage

Voltage regulation is obtained by means of a rheostat in series with the field windings of the generator. The voltage is raised from 0 to 40 volts at a rate not exceeding 5 volts per minute, and after attaining 40 volts it is held at that point for 30 minutes. Voltage regulation is by hand, but a recording voltmeter is required on Navy contracted jobs. An ammeter should be provided as a safeguard against overloading the generator.

Current Density

The current density of the anodizing process is generally stated to be 1½ to 2 amperes per sq. ft. minimum for the chromic acid process*. If the surface is rough or unsound, the current density will be appreciably greater than for sound metal. Sandblasted parts require more current than rolled or polished parts. Pieces of aluminum which have been worked up into special shapes by springing or hammering without subsequent polishing show current densities as high as 6 amps./sq. ft. The values for current density are the values attained after the voltage reaches 40 volts.

Instrumentation

Two recording instruments have been mentioned; the thermometer and the voltmeter. Their records must be dated and kept on file. In the event of a dispute with resident inspectors, these records can be blueprinted and mailed to headquarters in Washington, D. C. Such records carry a great deal of weight in such an eventuality. They are also helpful to the inspectors who must keep a record of every operation.

Other Records

The routine analyses of the anodizing solutions should be recorded to complete the records mentioned above. Such analyses should cover in the order of their importance: (1) free chromic acid, (2) chlorides, (3) sulphates, (4) total bases: aluminum, trivalent chromium, iron, (5) hexavalent chromium. I will only discuss the most important one here: free chromic acid.

Several Tests for Free Chromic Acid

(A) pH

For the determination of free chromic acid several methods have been proposed and are now in actual use. If we follow the suggested procedure of the National Bureau of Standards, we would measure the pH of the electrolyte by the electrometric method employing a glass electrode. A curve is proposed showing the relation of pH to the free chromic acid content.

(B) Conductivity

Another method determines the conductivity of the solution. The free chromic acid content is estimated from the conductivity measurement by direct proportion. The Solubridge is an inexpensive instrument suitable for such control work.

(C) Laboratory Titration

Another method determines the free acid by titration. The choice of a suitable end-point for the titration is a question over which there is much controversy.

(References given on page 136)



George C. Field

Charts developed at Cutler-Hammer, Inc. for calculating area of commercial round head screws and washers are reproduced. Control of thickness was found to be more reliably done on an area basis rather than on a weight basis.—Ed.

To meet the required standards of Cutler-Hammer products, a few years ago we began to plate to specifications and we went into a period of experimentation. At the start, we considered our equipment and decided to run the plating barrels one hour for each load. The size of the load was at first measured by weight, the purpose being to find the highest point of efficiency. If the barrels were overloaded, it was found that it took too long a running time. If the loads were made too small, too much handling time was wasted. Measurement by weight or volume was not the solution to the problem.

Since specifications depend upon current density, the power available was determined as well as the thickness of plating desired. The surface area was the missing part of our equation. By using surface area to measure our loads, we dispensed with weight and volume factors except when such characteristics became a physical limitation.

After a period of evolution, it was found that with our present equipment, 50 sq. ft. was the proper sized load for most of our work. Since area was so important a factor, a quick and efficient method of measurement was needed. To measure the surface area of round headed screws, was too much to ask of the workmen, so it was taken

Measuring Surface Area of Screws and Washers

BY GEORGE C. FIELD

Cutler-Hammer, Inc.,
Milwaukee, Wis.

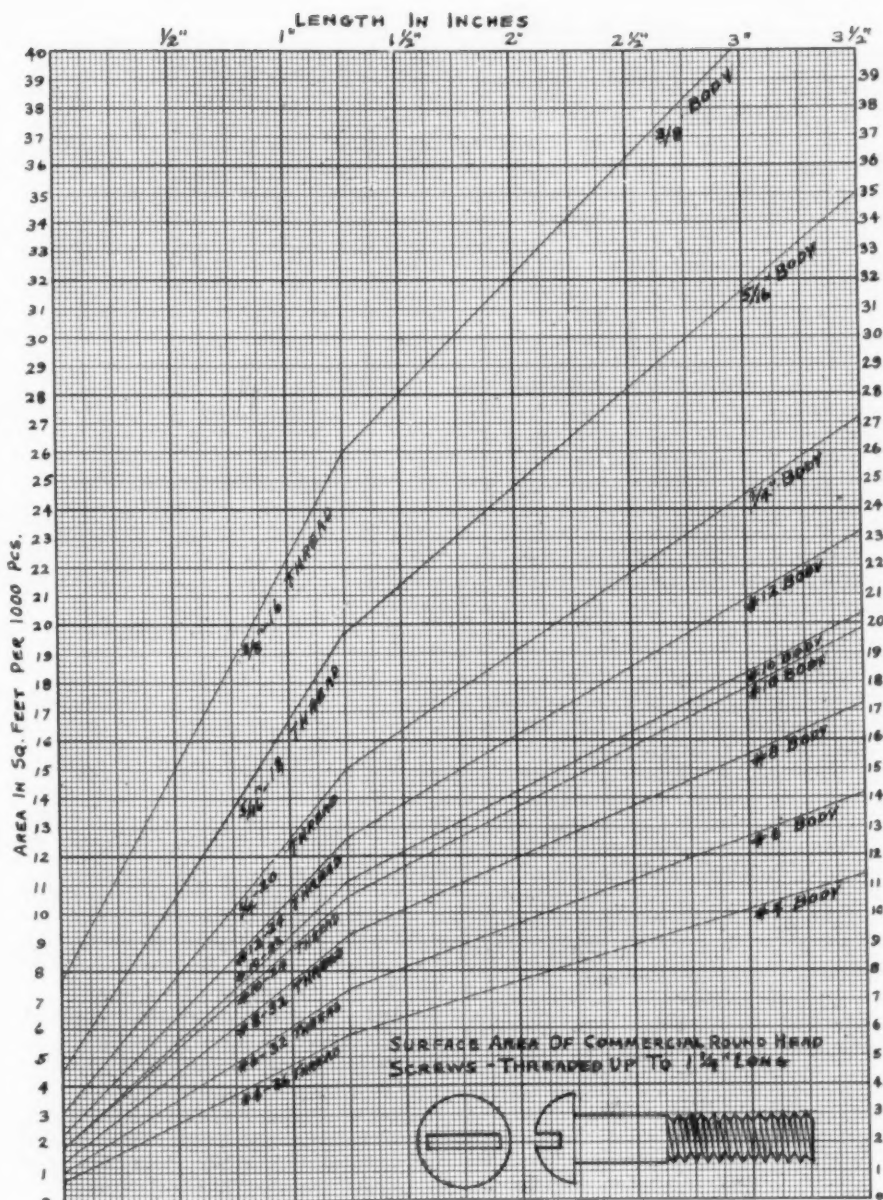


Fig. 1. Curves for calculating total surface area of commercial round head screws threaded up to 1 1/4" long.

up with the Routing and Time Study department who measured time values.

As a result, charts were made up to show the surface area of round head, and flat head screws, studs, nuts, washers and spacers, etc.

Herewith are reproduced charts for commercial "round head screws" and for "washers and spacers". We have used them since they were made and have found them to be very helpful.

The chart for commercial round head screws is primarily for screws threaded up to $1\frac{1}{4}$ ". Most commercial screws have no thread over $1\frac{1}{4}$ ". Consulting the screw chart then, the lines change from thread to body at $1\frac{1}{4}$ " length. The areas of the screw heads and ends are found at the starting point of each line. From that point, read to the right at the proper length seen at the top, then read the area at the left of the graph adjacent to the point where the diagonal line of proper screw size intersects the length line.

The chart for washers and spacers reads the same as the screw chart but provides added features. The lines above the horizontal "O" line are for areas of ends and of the outer cylindrical area. The areas below the horizontal "O" line give the inner cylindrical area with the area of the hole ends subtracted. This makes it possible to determine the area of washers and spacers by use of two figures. It will be seen that when the area of the hole ends exceeds inside cylindrical hole area that it will fall above the "O" line. This means that such minus quantity will have to be subtracted from the figure area of washer. (See note on graph). If the figure falls below the "O" line, then add to the figure found above the line.

Anodizing of Aluminum

(Concluded from page 134)

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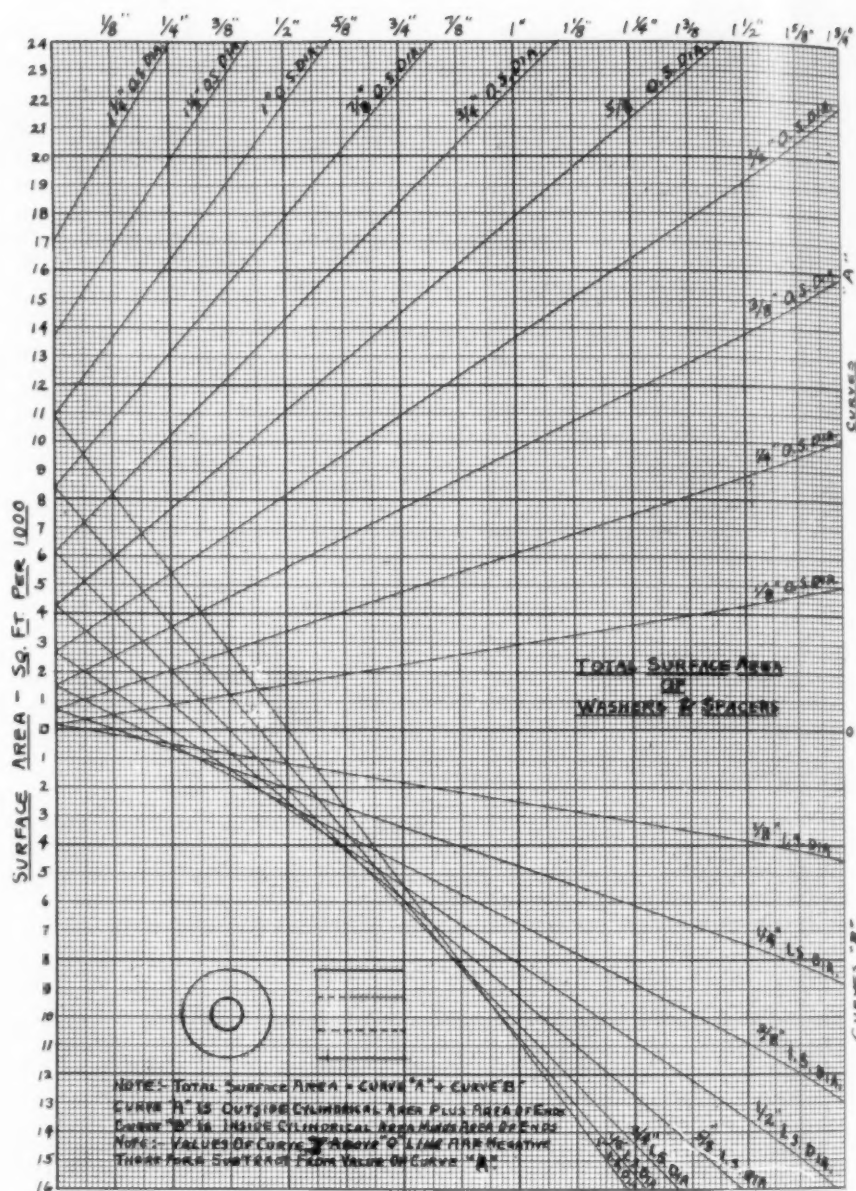


Fig. 2. Curves for calculating the total surface area of washers and spacers.

General Instructions for Protective Treatment of Aluminum and Aluminum Alloys by Anodic Oxidation Process; with Amendment No. 1 (August 30, 1938).

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There must have been wonderful silver-smiths and goldsmiths back in Bible times, for we read (Ezra 1st chapter) of the treasure brought up from Babylon to Jerusalem "all the vessels of gold and silver were five thousand four hundred." These vessels must have been hand made for there were no duplicating machines in those days.

+

In New York City there are 9,500,000 miles of telephone wire,—enough to go 380 times around the world.

+

A person telegraphing between New York and San Francisco utilizes 1,600,000 pounds or about 800 tons of copper.

Fundamentals of Science Relating to Electroplating

Chapter VII. Chemical Reactions and Equations

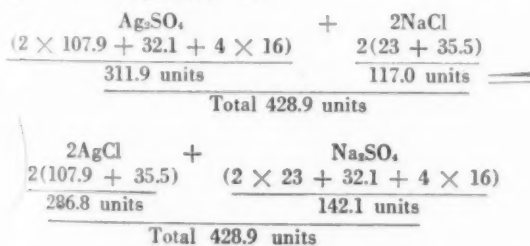
"You can't make something out of nothing" is a popular, and usually innocent way of expressing one of the laws of science, which states, a little more elegantly, that "matter can neither be created nor destroyed, only transformed." The coming of Einstein and the resulting revolutions in science have shown that this law, as all other laws, has its minor exceptions, but for our purposes the statement is certainly true enough. Electroplaters are applying this law almost continually: when a metal is being pickled nothing is being really lost, metal is merely transformed into a salt; when metal is being plated, nothing is being created, the metal ions are merely being transferred into neutral metal atoms; etc. etc.

In chemistry, this "Law of the Conservation of Matter" naturally applies to all actions and reactions involving chemicals, and makes it possible to describe just what happens to the substances in any particular case very conveniently by means of an *equation*. For example, in the case of precipitation and purification of silver from a sulfate solution by adding table salt, we can write, in our chemical shorthand, this equation:



This merely means that one molecule of silver sulfate reacts with two molecules of sodium chloride to give two molecules of silver chloride (the white precipitate) and one molecule of sodium sulfate. The water that was used as a medium for carrying out the above isn't mentioned, because it is the same after the reaction as before. Now a few things should be pointed out as being *always* true about equations. In the first place, we know from experiment and reasoning that the products shown on the right hand side are actually obtained from the starting materials shown on the left hand side. In the second place, there are the same number of atoms of each element on both sides of the equation. (Remember that 2NaCl , for example, means two atoms of sodium and two atoms of chlorine). In the third place, and this follows from the above, the total weight of materials started with, equals exactly the total weight of the products. In the fourth place, the materials will always react in the proportions by weight shown by the molecular weights.

To illustrate just what this latter statement means, let us rewrite the equation, putting underneath each molecule the proper atomic weights multiplied by the corresponding number of atoms and let us put down, by adding the above, the resulting combining or reacting weights for this equation, thus:



Let us take as an example the specific question: If we had 100 ounces of silver sulfate to begin with, how much pure table salt (sodium chloride) would be needed to precipitate all the silver? Answer: If 311.9 ounces of silver sulfate require 117 ounces of table

salt, 1 ounce of sulfate would require $\frac{117}{311.9}$ or 0.375 ounces of salt.

Therefore 100 ounces of silver sulfate would require $100 \times 0.375 = 37.5$ ounces of salt. In a similar manner, the quantity of each product could be computed for the same 100 ounces of silver sulfate,

(e. g. $\frac{286.8}{311.9} \times 100 = 92.0$ ounces of silver chloride formed). From

a previous chapter, we know also that 100 ounces of silver sulfate contain $\frac{2 \times 107.9}{311.9} \times 100$ or 69.2 ounces of silver. It is thus evident

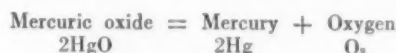
that by means of atomic weights, molecular weights and equations, many problems in chemistry can be simply solved.

Chemical changes also involve energy changes, which may be manifested in various ways. When iron and sulfur react together, *heat* is given off; when magnesium is burned in oxygen, as for old-fashioned flashlight pictures, *light* is produced (the light from fireflies is due to chemical reactions in their bodies); when zinc and copper are used in the proper solutions, *electricity* is produced; and chemical explosions produce *mechanical energy*. Conversely, all these forms of energy may be used to cause chemical reactions: the application of sufficient heat will decompose trichlorethylene; light causes reactions in photographic films; electricity decomposes compounds to make electroplating possible; and mechanical action such as rubbing will produce compounds (e.g. silver chloride) otherwise not formed under those conditions.

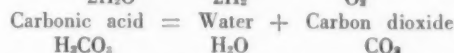
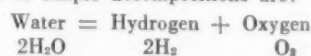
Now it might seem to the uninitiated reader that there would be an endless number of kinds of equations that could be written, since there are so many different compounds to react. Fortunately, the number of different *kinds* of equations does not require, for counting, the fingers of even two hands, as should be evident from the following classification of what can happen when chemicals, or a chemical and some energy, get together. There can be:

(1) Simple Decomposition

As the name implies, this reaction consists of breaking down a substance into its constituents. For example, when mercuric oxide is heated, oxygen is given off and mercury is left. The equation is written:



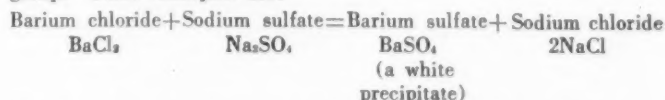
Other examples of simple decompositions are:



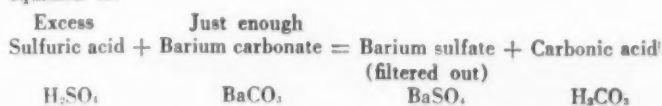
In a sense, all plating can be considered a form of decomposition, caused by the flow of electricity. In an acid copper bath, for example, the copper sulfate is decomposed into copper and, by further reaction, sulfuric acid, but this all-important and specialized process will be discussed separately in the future.

(2) Double Decomposition (also called Metathesis)

This is the commonest type of reaction and the one on which the greatest part of qualitative and quantitative chemistry is based. In this case, two substances are decomposed and then "swap partners". The precipitation of silver described above belongs to this group. Other examples are:



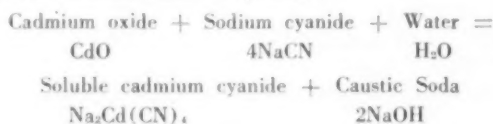
The fact that the white precipitate of barium sulfate forms whenever barium and sulfate get together makes it possible to test for one of these by adding the other. In chromium plating solutions, when the sulfate-chromic acid ratio is too high, the sulfate is removed by a similar reaction by adding barium carbonate. The equation is:



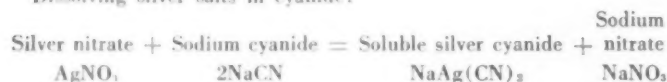
Carbonic acid then undergoes simple decomposition as described above into water and carbon dioxide and it is the escaping carbon dioxide that causes the bubbling in the chrome solution.

Some other reactions under this heading of interest to platers are:

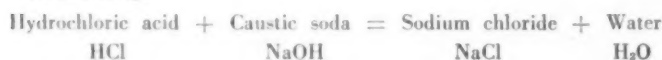
Dissolving cadmium oxide for plating:



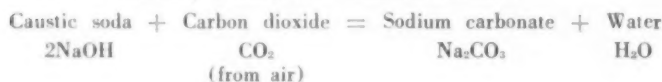
Dissolving silver salts in cyanide:



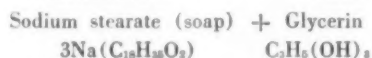
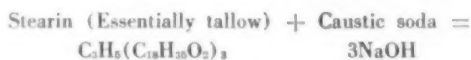
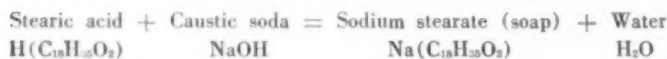
Neutralizing:



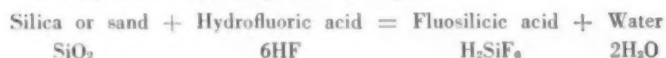
Loss of alkalinity (caustic) in alkaline cleaners:



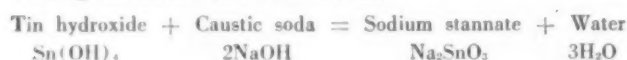
Formation of soap from polishing dirt and alkaline cleaner:



Etching glass or pickling sand castings:

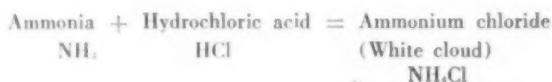


Clearing tin anodes with caustic soda:



(3) Combination or Synthesis

The title is self-explanatory and a familiar example is the formation of a white cloud whenever ammonia and hydrochloric acid vapors mix. The reaction is



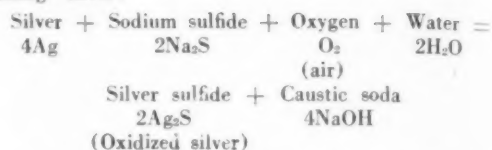
(4) Oxidation and Reduction

This group has many reactions that are in a sense combination reactions as well, since they may represent merely combination with oxygen. The word *oxidation* in its general sense is used to designate an increase in the valence of an element, even though the addition of oxygen is not always involved. The word "oxidize" as used in metal coloring, has developed to a somewhat different meaning, signifying a dark, if not black coloration. Actually, oxidation in the real chemical sense is also involved here, as will be illustrated below, so that the name is not entirely a misnomer.

Reduction is the opposite of oxidation, designating a decrease in valence and often the addition of hydrogen. Electroplating is a reduction reaction and, in general, all reactions taking place at the cathode are reduction reactions. The reactions at the anode are oxidizing in nature.

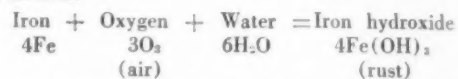
From the very nature of the thing, it is evident that whenever one element is oxidized, the element causing this oxidation is reduced, so that the increase in valence in any reaction equals the decrease. The following equations will illustrate these points, bearing in mind that a neutral (i.e. un-ionized) element may be said to have a valence of 0 and that air, which is rich in oxygen, causes many a reaction of importance to platers.

"Oxidizing" silver:



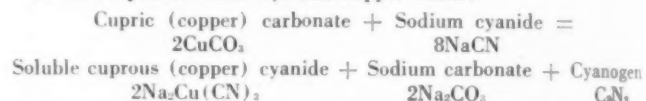
(4 silver atoms change from a valence of 0 on the left side of equation, to a valence of +1 on the right side, making a total increase of 4 valence units, while 2 oxygen atoms simultaneously change from a valence of 0 on the left side to a valence of -2 on the right side, making a total decrease of 4 valence units).

Rusting of iron:



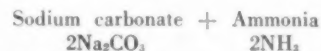
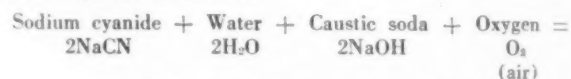
[4 iron atoms go from a valence of 0 (on the left side) to a valence of +3 (right side) making an increase of 12 units while 6 oxygen atoms go from a valence of 0 (left side) to -2 (right side) making a decrease of 12 units].

As some platers make cyanide copper baths:



[The copper has been reduced from a valence of +2 (cupric) to a valence of +1 (cuprous) while the cyanide radical (CN) has been oxidized to cyanogen, a gas which is very poisonous and which represents a waste of cyanide to the plater. It is cheaper, therefore, to start with a cuprous salt, like cuprous (copper) cyanide].

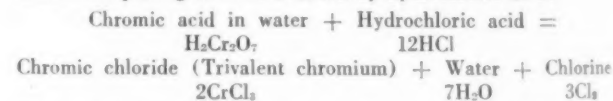
Loss of cyanide in solution:



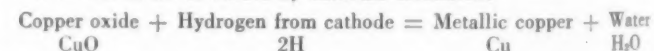
[Oxidation of the cyanide result in the formation of carbonate and the odor of ammonia]. The following may also happen:



Chromium plating solution reduced by hydrochloric acid:



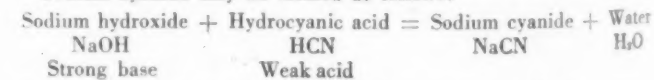
Removal of metal oxides by cathodic treatment:



(5) Hydrolysis—Reactions with Water

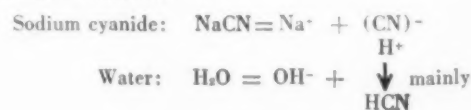
Salts of which at least one component is a weak acid or a weak base possess the property of reacting with water, to form an acid and a base, which reaction is called *hydrolysis*. It will be noted that this is really the reverse of neutralization, in which the important reaction is the formation of water. The importance of this property can hardly be stressed sufficiently. The reason it exists can be readily explained on the basis of what we have already discussed under ionization and a simple example such as sodium cyanide may illustrate it.

Sodium cyanide may be formed as follows:



and it therefore falls under our requirements for hydrolysis.

When sodium cyanide is dissolved in water, like all salts, it ionizes into sodium ions and cyanide ions. In solution, therefore, ions are formed as follows:



SHOP PROBLEMS

Red In Gold Solution

Q. In dissolving fine gold by the porous cup method, I frequently find that after the current has been on only a few minutes, the solution becomes deeply colored (dark red) and this color takes some time to filter out. I use 35 dwt. potassium cyanide to a liter of water in dissolving 14 dwt. of fine gold, using stainless steel or sometimes duriron as cathodes.

Will you please advise me how to prevent the dark red color from forming.

A. The color is in all probability due to finely divided gold. This may be due to a chemical action, as for example might result from the use of stainless steel or duriron cathodes. It would be better to use hard gas carbon cathodes.

Finely divided or colloidal gold will come off the anodes if you have a certain condition of anode current density and cyanide concentration.

It is suggested you make trials to determine if you can get some condition where the red coloration does not form. In order to know where you are working, put an ammeter in the circuit.

Then, keeping the cyanide and gold anode area the same as usual, try different currents. If no success is had, try different concentration of cyanide, keeping other factors constant. In this way you will work out some set of conditions where the gold will dissolve without the formation of the color.

It is our opinion that you are using too high an anode current density. This can be corrected by increasing the anode area, or by using a lower current on the present anode arrangement.

G. H. B., Jr.

Silver Residue

Q. I am sending you a sample of silver residue recovered from a cyanide plating solution. I would like to know how to use it again, and how to add hydrochloric acid to recover the silver. I have some silver which was recovered from cathodes, and have tried to dissolve it in a pure silver solution with an excess of potassium cyanide. I find the process is very slow, and I would like to know if I can use a quicker method.

How long can silver cyanide strips be used and is there any indication when they are saturated with silver?

A. The residue in the sample of liquid submitted is soluble in sodium cyanide solution. Inasmuch as some acid is present in the residue, any solution made with cyanide should be done under well ventilated conditions.

We have no way of determining what impurities might be present in the residue that would effect the plating properties of your

Technical Advisor For March Issue

G. B. HOGABOOM, JR.,
Consultant in Electroplating
and Metal Finishing,
Newark, N. J.

solution, unless a plating test is made with an appreciable amount of the dissolved residue added.

The safest procedure would be to accumulate your silver scrap, etc., and send it to a refiner. In this way you will not be taking a chance of contaminating your plating solutions.

There is no fixed rule on when to recover the silver from a stripping solution. It is best to work on the basis of making up a new strip solution when the old strip fails to properly strip work to be refinished. A poor stripping job on a complicated article will cost more to refinish due to excessive polishing, than the amount of silver saved by using an old strip too long.

The amount of silver in the strip can be determined by chemical analysis using a method similar to that given for silver on page 106 of the 1940 edition of the Plating and Finishing Guidebook. The amount of silver present in the strip would not affect its action as much as the concentration of the active ingredients and if a study of the strip is desired, these should be controlled.

Metallic silver is not readily soluble in cyanide solutions without the use of current. The metal can be dissolved in nitric acid to form silver nitrate. After boiling off the excess nitric acid, hydrochloric acid can be added to precipitate silver chloride. Wash this precipitate well by decantation and dissolve it in sodium cyanide solution. 1 oz. of silver chloride (pure and dry) requires about 0.7 oz. of sodium cyanide to take it in to solution. Here again, it would be better to send this silver scrap to the refiner for the reasons given above.

—G. B. H., Jr.

Government Bronze

Q. I would like to know how to produce the black finish used on Government goods, such as buckles, eyelets, etc., and referred to as "Government Bronze Finish."

A. A resistant black finish is obtained on army buttons, etc., for the Government bronze finish, by tumbling the work in a solution of copper nitrate. The work is

then baked in a rotating drum, the fumes being led away. Then roll in sawdust to remove the smut. The copper nitrate solution is simply a saturated solution of that salt in water. A solution of copper nitrate can be made by adding an excess of copper metal to concentrated nitric acid.

It is better to tumble the work with enough copper nitrate solution to have the work moistened thoroughly and have the solution evenly distributed. The work should not be dripping with copper nitrate solution. It is then placed directly in the baking drum without rinsing or drying.

The baking is at a temperature of 400-450° F. and for a period of time sufficient to burn off all the fumes, which will require about an hour. The fumes are very obnoxious and a good exhaust system is required.

While the above finish is the preferred one when army bronze finish is called for, it cannot be conveniently applied in many shops. In such cases, a regular copper oxidize finish is used. That is, the articles are copper plated and dipped in a sulfide solution.

The antimony sulfide-caustic soda dip can also be used, such as the formula on page 74 of the 1940 Plating & Finishing Guidebook.

Golden antimony sulfide 4 ozs.

Caustic soda 8 "

Water 1 gal.

Temperature from 160° to boiling point

This dip will not give very quick results directly on brass; better to copper plate first. If putting direct on brass, allow some time.—G. B. H., Jr.

Gold Plating Pen Points

Q. I would like to know how to plate steel pen points with gold.

A. If it is desired to gold plate directly on plain carbon steel, use the gold solution formula as given on page 55 of the 1940 Plating & Finishing Guidebook.

Potassium gold cyanide ½ oz.

Potassium cyanide ½ "

Water to make 1 gal.

Temperature 140-160°F.

Current density ... 1 to 5 amps./sq. ft.

Voltage 2 to 4 volts

The solution can be held in an enameled pot which is heated from beneath with an ordinary gas burner. Gold, stainless steel, or gas carbon anodes may be used. With the use of insoluble anodes, the gold plated out of solution is replenished by the addition of more gold salts (potassium gold cyanide). It would be desirable to nickel flash the points before gold plating.

If the pen points are made of stainless steel, a method for gold plating in this case is covered by patents 2,039,326 and 7.

—G. B. H., Jr.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Blackening Process for Zinc and Its Alloys

The Enthone Co., 442 Elm St., New Haven, Conn. have announced the development of an immersion process for the blackening of zinc and its alloys. The process called, "Ebonol Z", consists in immersing the zinc or zinc alloy in a 1 lb. per gallon solution of Ebonol Z salts in one gallon of water at a temperature from 150 to 212° F. An adherent, jet black finish is formed in from 1 to 5 minutes.

The work is cleaned in alkaline cleaners or degreased with solvents and acid dipped similarly to preparing work for plating, before being treated in the blackening solution. According to the manufacturer, 1 lb. of salts will blacken over 150 square feet of zinc surface. The bath is not critical and requires little control.

It is reported that the Ebonol Z solution can be used for producing a black coating on stainless steel, nickel silver, nickel, and noble metals by making a couple with these metals and a piece of zinc. This can be done by using a zinc basket or by fastening a sheet of zinc to the rack or basket in which the metals are to be blackened. The process is stated to be particularly valuable for nameplate finishing where recesses are to be blackened, for blackening of etchings on rules, squares, tools, etc.

It can be used for blackening zinc plated or hot galvanized surfaces as well as for solid zinc or its alloys. The blackening process is stated to be particularly timely for armament purposes as it allows the blackening of zinc and other metal surfaces to reduce or eliminate glare and, in addition, the thinness of the coating obviates any possible difficulties from a dimension tolerance standpoint. Unlike plated or enameled coatings, the Ebonol Z coating does not change the thickness of the piece more than a few hundred thousandths of an inch and thus close dimensions can be maintained.

The company reports that they will be pleased to blacken sample parts for examination or tests, and are prepared to render engineering service on the blackening of zinc, stainless steel, steel and other alloys.

Adjustable Speed Polishing and Buffing Lathe

Bruce Products Corp., 5712 Twelfth Street, Detroit, Mich., have announced the development of a new adjustable speed polishing and buffing lathe called their Model "DAS". The lathe features double motor, double spindle and dual controls,



Adjustable speed polishing and buffing lathe.

and the company has incorporated in this model, a rugged and sturdy adjustable speed control that is said to be easy to operate and to give long and dependable service.

The speed control mechanism can be adjusted while the machine is in operation by an accessible control unit near the motor switch shown in the illustration.

The model is available with a speed range of from 600 minimum to 3480 R.P.M. maximum. It is available with either two 2 H.P. or two 3 H.P. motors. The over-all spindle length is 60" with distance between wheels of 48". The wheel face is 4" and the height from floor to center of spindle is 38".

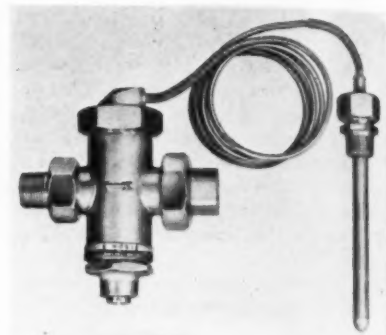
Accessories applicable to this model lathe include taper screw points, dust hoods with mounting brackets, high speed auxiliary wheel spindles, abrasive belt grinding attachments and composition applicators.

Temperature Control

Sterling, Inc., 3665 N. Holton St., Milwaukee, Wis., have announced another item in their line of temperature control instruments, namely, their No. 150-A Thermotrol.

This control is a direct acting valve (closing on rise in temperature) for the control of water or other liquid temperature. Its function is to provide a modulating flow of water, steam or gas, and to control temperature within 1½° F. plus or minus.

The thermal bulb is installed in either a tank or liquid line. Change in temperature at the bulb, increases or decreases pressure within the bulb. This change in pressure is transmitted through the copper capillary tubing to the bellows at the bottom of the valve housing.



Direct acting control for controlling temperature of water or other liquids.

The pressure in turn is transmitted to the valve stem, opening and closing the valve.

The standard thermal bulb is copper for immersion in non-corrosive liquids. Bulbs with protective shields of special metals or special plating to resist various corrosive solutions are available.

The instruments are available in two standard pressure ranges, namely, 0 to 30 pounds, and 0 to 125 pounds, and are built in three sizes: ½", ¾" and 1". The standard temperature range is 120° to 170° F., although instruments are available for controlling temperature in various ranges from 70° F. to 270° F.

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STANDARDS OF CLARIFICATION

R. J. Green

*Alsop Engineering Corporation
Milldale, Connecticut*

When speaking of the depositing of metals from electrolytic solutions, one might use a customary title concerning this process "as the art of electroplating." During the early days of plating, and up until a comparatively recent time, the term "art" was amply justified. However, in recent years, the applied chemistry and direct research of the chemists and engineers into the process of electroplating have caused the "art" to be developed into a highly specialized field.

Our common ordinary nickel bath has graduated to a point where with a little "coaxing," it will produce a very brilliant deposit. In some cases this deposit is sufficiently bright enough to eliminate nickel buffing. Our simple copper cyanide bath has been developed to where it will produce exceedingly bright deposits and at a very high rate of speed. These improvements and new methods, etc., have not been confined to the above-mentioned solutions, but are prevalent throughout the entire industry. But the amazing improvements of the above solutions are certainly indicative of the trend of the times. It is probably safe to say that the high speed bright nickel, and bright copper, etc., have ceased to be regarded as a phenomenon of the chemist's laboratory and have taken their place in our production lines.

Cooperation

The fact that these new ideas and new methods in new designs and equipment have been so successful in such a comparatively short time, is due primarily to the hearty cooperation between the chemists and the practical men. We might say here, that this cooperation has been made possible through the untiring efforts of the American Electroplaters' Society, whose policy has been to promote and encourage a genuine spirit of friendliness between these men, composing the membership of this society. Among other publications, the METAL FINISHING certainly deserves prominent mention for its part in presenting many practical and technical papers pertaining to the interest of the electroplater.

Filtration Not Considered Essential

In earlier methods of plating, the job of keeping the baths clean was not considered to be a vital factor for successful plating. In fact there were some platers who liked their solutions a little "cloudy," and others who cleaned or filtered their solution once a year, and still others who only cleaned their baths when they had to. That is when the mud accumulated on the tank bottom so deep, that the racks would touch it. The only adequate methods of filtration available to

the plater in those days, involved the use of huge mechanical filter press, or he could let the solution "stand" or settle for two or three days and then syphon or decant the clear (?) liquid into a separate container. This method involved the loss of a large amount of solution, for as soon as the liquid became turbid, the "filtration" stopped. The solution left in the bottom of the tank was either removed and placed in a separate container and allowed to settle for subsequent recovery, or thrown away.

Portable Filters

The advent of the small portable filter was certainly a boon to the plater. However, it was soon found that in order to secure a real fine filtrate, a filtrate that would incorporate a definite improvement in the plated work, it was necessary to use some outside filter aid just for ordinary filtration. As previously mentioned, a really fine filtrate was not considered essential in those days. Therefore, the job of designing an adequate type of small portable filter was given little attention.

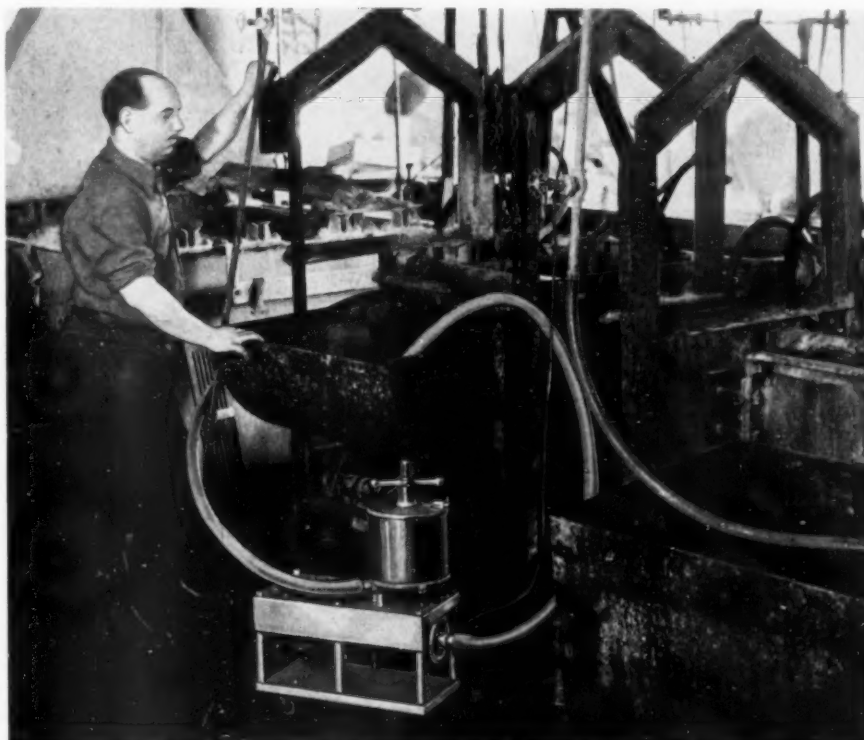
A Need to Be Met

Now, with the general acceptance of the new bright fast plating copper and nickel solutions, etc., the increased demand for pro-

duction has resulted in a definite demand for a small portable filter which will not only keep the solution clean, but will help to keep it purified, help to keep down the rejections. This filter should be small enough in bulk, so as not to take up too much available space. It should be very readily cleaned. The filter media should be composed of suitable discs or pre-made filter cakes, so that by merely changing the filter discs, any desired degree of filtrate may be obtained. One of the prime factors to be considered in the successful operation of bright nickel, is cleanliness, not only of the work to be plated, but of the solution itself. This process goes a step beyond conventional methods, and actually demands clarification.

Modern Sealed Disc Filter

Just as our modern bright fast plating solutions are products of the laboratory originating with the specialists, so it has remained for a group of engineers and specialists who have specialized in difficult problems of liquid clarification, and who have been designing and building filters for over 20 years to develop a filter, especially for the plating field. Peculiarly adapted to the successful operation of the modern high speed plating solution, the need to be met was given careful consideration, so that the modern "Sealed Disc Filter" has been constructed in such a manner that it will not only deliver an exceedingly clear filtrate under the most exacting conditions, but this same ultra clarification is available to the plater, even where ordinary conditions of filtration are encountered. For this type of ordinary filtration, it requires no outside aid or no excess filter powders, etc. Yet, on the other hand, it may be necessary to remove oils and greases and foreign metals from a bright nickel bath.



Barney North, plating foreman, of Patent Button Co., Waterbury, Conn., filtering a solution with a sealed disc filter.

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"4-A" Polishing Compounds Are Faster, More Efficient, More Economical for Polishing, Mirror Finishing of All Kinds of Steel, Including Stainless Steel and Other Alloys.

Use it on any kind of a wheel, soft, hard, medium. Results will speak more eloquently than anything we could say.

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CEMENT AND THINNER

Instead of glue, use "4-A" Cement and Thinner, a uniform substitute for polishing Wheels, Belts, Buffs, Rolls, etc.

Samples of Compound or Cement sent on request.

HARRISON & COMPANY
HAVERHILL, MASS.

One of the chief reagents used for this purpose is activated carbon, a substance so light in weight that a few pounds will occupy a sizeable area.

The designers of this new "Sealed Disc Filter" have foreseen this process, and have provided ample space in the filter chamber for a reasonable amount of "cake" or sludge formation. Yet, these units can be cleaned, and new discs installed in less than ten minutes. The versatility of these units is one of their outstanding features. They can be used to clarify different solutions by merely changing the discs, and neutralizing the filter assembly, an operation requiring approximately fifteen minutes. There are no unnecessary fittings or blind corners incorporated in the design, so that the unit can be used with perfect safety. There is no fear of contaminating one solution with another.

Activated Carbon and the Sealed Disc Filter

One practice when using activated carbon

in the process of purification, is to thoroughly mix the carbon into the liquid and allow it to settle, preferably, over night before beginning actual filtration. In this way, the large particles of carbon will settle to the bottom of the tank. However, it has been found that even though the large particles will settle out, there still remains a large portion of tiny minute particles of this material in suspension in the liquid. The complete removal of these very minute particles is assured when using the new "Sealed Disc Filter." The pre-made filter cakes or laminated disc presents a coarse or open structure to the filter plate, and as the dirty liquid penetrates the disc, the apertures gradually decrease in density, so that even these most minute substances will be stopped, and the liquid as it emerges from the other side of the disc is clear and sparkling.

A Difficult Problem

There is a definite need of this type of filtration in the plating field today. As an

illustration of this fact, let us consider a problem of electroplating that presented itself to the Patent Button Company, of Waterbury, Connecticut. The products of this company are universally known throughout the industry, and their finishing methods are exacting. About a year so so ago, they were called upon to plate a small attachment for a modern lighting fixture, which seemed to be a simple matter. However, it was soon found that any impurity occluded in the plate, would actually decompose and discolor the lighting fixture. Research on this problem light gave off intense rays, and these rays coming in contact with the impurities that were in the plate, caused the trouble. The work was checked for cleanliness before plating. New methods of cleaning were devised and tried out, but to no avail. The plating solution was carefully analyzed and all the component parts were brought into balance with one another. Still the trouble persisted. Then, constant filtration was tried. This seemed to help, but not enough to stop the trouble. Filter aids and special impurity removing powders were used in conjunction with the filter, and immediately a marked improvement manifested itself in the finished product. However, the trouble did not entirely clear up. It would appear for a while and then disappear.

Definite Standards

Finally, it was discovered that the filter aids and powders had a tendency to fall off the filter bags whenever the filter was stopped, so that upon again starting the machine, some of the unfiltered liquid would pass right through the filter bags, back into the solution, usually carrying some of the minute particles of filter powders and filter aids with it. About a year ago, one of the new "Sealed Disc Filters" was placed on this particular tank. It incorporated as filter media, one of the regular grades of pre-made filter cakes or discs having a definite density. The results were amazing. The combination of all factors contributing to the success of this particular process when taken into consideration resulted in definite procedures and standards of operation. A standard of metal cleaning was set up, a definite cycle established and rigidly adhered to. The formula of the plating bath was revised and built to a definite standard. Each component part of this bath was controlled by chemical analysis. The anodes were formulated so as to provide the maximum of purity, and finally a definite standard of clarification was established; hence any impurities existing in this bath were removed before they had an opportunity to do any harm, and constant filtration helps to keep this solution functioning properly. This type of filter required no outside filter aid and no powders, so that no matter when it was stopped, or how long it is shut down, it can be started by merely turning the switch and the filtrate will be just as clear as when it was stopped.

Welding Alloys

Park Sales Co., 3 Park Place, New York, who introduced on the American market, in April, 1940, a new welding material made in

Switzerland, has found it impossible to import this product any longer, and has, therefore, started to make a similar product in the United States, and is selling it under the name of "Weldoloy", and is being distributed under the firm name of Weldoloy Mfg. Co. (a division of the Park Sales Co.).

This material is available in a variety of alloys and fluxes for oxy-acetylene welding and, according to the manufacturer, enables welding operations to be performed at unusually low temperatures. Because of this feature, overheating and subsequent warping of welded parts are said to be avoided and stresses eliminated. These alloys are supplied in rod form and the fluxes in powder or paste form.

These alloys, for the steel, aluminum, brass and bronze industries, are now available, outstanding of which are No. 690 and No. 685. No. 690 is used for the welding of aluminum and its alloys and flows at a temperature of 930° F. According to the manufacturer, this material has great tensile strength (35,000 lbs. per sq. in.) and durability, and is particularly useful in the aviation and automobile industries. No. 685 is used for building up on steel, cast iron, copper, brass, bronze and so on. This alloy flows poreless at 750° F. and, though of a hardness of 230 Brinell, can be easily machined. It is said to be an ideal material for repairing broken or worn parts of machinery. Other alloys available which have binding temperature as follows are: No. 514 for cast iron binds at 360° F., resistant to pressure at 8 atm. No. 516 for steel binds at 1470° F., tensile strength, 115,000 lbs. per sq. in., particularly recommended for thin gauge steel. No. 518 for copper, brass, extruded bronze, binds at 1600° F. and is poreless. Tensile strength, 65,000 lbs. per sq. in.

No. 710 for cast aluminum binds at 950° F., tensile strength, 23,000 lbs. per sq. in. No. 688 for die casting (white metal) binds at 750° F., high tensile strength.

Complete details are given in pamphlet W 27, copy of which is free.

Pre-Set Free Vane Controller

The Bristol Company, Waterbury, Conn., announces the addition of a new throttling-type air-operated temperature controller to its line of Free-Vane Automatic Control Instruments. This instrument, known as "Bristol's Pre-Set Free-Vane Temperature Controller", was developed for use on processes where the thermal characteristics are such that there is a tendency for the temperature to exceed the control setting of the instrument on the initial rise.

Many processes, particularly batch processes, that are started-up and shut-down at frequent intervals have heating characteristics which cause over-shooting of the control point on the starting-up cycle. This is due primarily to slow rate of circulation and resistance to heat transfer. An example of this type of process is the jacketed cooling unit where the jacket has appreciable mass and requires considerable cooling medium to arrive at the desired temperature.

On processes of this type, the controller introduces a presetting effect that is pro-

How ARE THEY USED?

MICCRO-SUPREME STOP-OFF LACQUERS MICCROLITE MICCROLAC



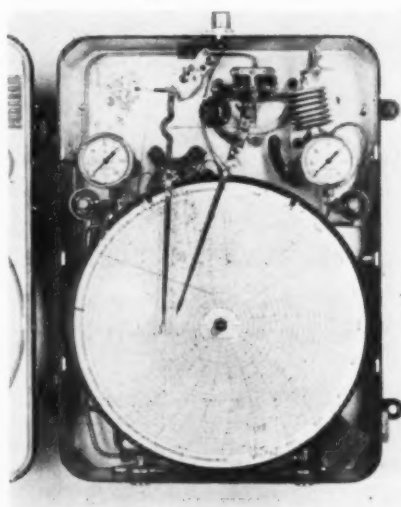
• **FOR INSULATING PLATING RACKS FOR DECORATIVE PLATING:** Micro-Supreme Stop-Off Lacquers and Microlite meet every protective requirement for plating racks used for any purpose. Dipping is the recommended method of application, and is followed by air-drying or force-drying at 125° to 150° Fahrenheit. Microlite can be applied faster and will air-dry faster than the Stop-Off Lacquers. For either material, no preparatory work other than cleaning the surface to be coated is required.

• **FOR MASKING PARTS FOR HARD CHROMIUM PLATING:** Micro-Supreme Stop-Off Lacquers HR-302 (Red) and HB-401 (Black) are supplied for this purpose. They have exceptional adhesive qualities but can be removed easily after plating. Rapid air-drying qualities reduce time between coating and preparation for plating to a minimum. Extremely accurate plating work is assured, with no possibility of etching in precision-lapped or super-finished parts.

• **FOR PROTECTING and BEAUTIFYING NATURAL METAL OR PLATED SURFACES:** Microlac is the new water-white, non-blushing material used for this purpose. It is particularly adaptable as a protective coating for silver-plated, polished brass or brass-plated products, and is used on copper, aluminum, wrought iron, stainless steel, etc. It has proved to have excellent adhesion to cadmium, chrome, or other greasy surfaces, and is not affected by sulphur dioxide, sunlight, moisture, oil, grease and gasoline fumes. It comes ready for use, requiring no thinner.

FULL DETAILS CONCERNING THE MICCRO PRODUCT BEST SUITED TO YOUR NEEDS WILL BE MAILED IMMEDIATELY UPON REQUEST.

MICHIGAN CHROME & CHEMICAL CO.
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portional to the width of throttling range and also rate of change of the condition being measured and controlled. The controller action occurs prior to or during the approach of the pen to the control point. It tends to decrease the rate of change of position of the pen and permits the controlled temperature to gradually approach the control point.

The magnitude and duration of the pre-setting effect may be adjusted over a wide range by a convenient adjustment of a pointer on an arbitrarily calibrated dial.

The temperature controller is said to have been used with a high degree of success on difficult control applications of which the shredder in the manufacture of rayon and cellophane is an example.

(Left) Open view of air-operated temperature controller.

NUCHAR


ACTIVE CARBON

SAVES

TIME AND MONEY

By treating plating solutions with NUCCHAR Active Carbon you can avoid the loss of time and money due to extra buffing made necessary by plating with contaminated solutions. The original cost of the NUCCHAR Active Carbon is repaid many times over in the improved quality of the plating.

If you are having difficulties with depositing a satisfactory bright nickel plate, we suggest you treat your plating solution with active carbon. NUCCHAR Active Carbon can be purchased from our jobbers throughout the country. Write for further information and the grades of NUCCHAR specially recommended for purifying electro-plating solutions.

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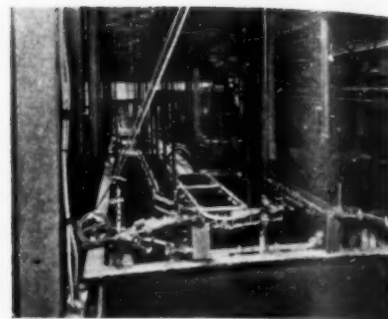


Fig. 2. U-shaped nickel plating tank.

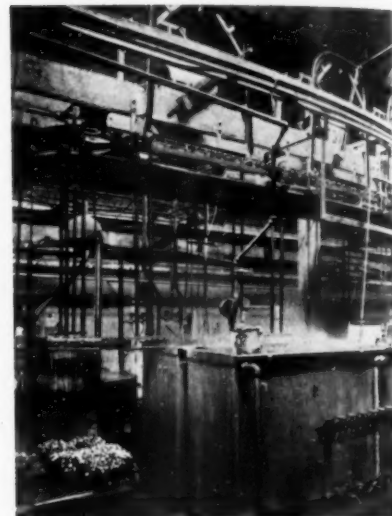


Fig. 3. Conveyor after passing through the process and ready for discharging.

different sized sections of copper tubing filled with a temperature-sensitive medium which expands and contracts a small diaphragm attached by high heat resistant solder to one end of the tube. The large tube is swaged to fit the smaller one and acts as the bulb which is inserted into the oven. One end of the tube is left open for the activating medium which is forced into it by the alternate use of vacuum and pressure, and finally sealed.

A series of checks and calibrations is again made and the units are then loaded on the automatic Corronizing plant conveyor which completes the processing cycle in approximately forty minutes.

The Corronized thermostat is removed from the conveyor and sent to the assembly lines where it is attached to valves and controller bodies which will maintain within a fraction of a degree the temperature of any heating unit.

The Robertshaw Thermostat Company, who are also electroplaters of nickel, tin, chromium and copper, have found Corronizing to be vastly superior, for this application, to any other coating in use today. They have expressed complete satisfaction with the corrosion resistance and the adhesion of the electroplate to the base metal even when the complete unit is subjected to the numerous bends and coiling operations necessary for insertion into modern, streamlined stoves.

The equipment for the Corronizing plant,

Corronizing Plant in Operation on Thermostat Elements

By John E. MacQuilken
Standard Steel Spring Company
Coraopolis, Pa.

The Robertshaw Thermostat Company of Youngwood, Pa., producers of precision thermostatic control units and one of the original licensees of the Corronizing process, is now in production of Corronized thermostat elements. The Corronized coating, predominately a thin non-porous nickel plate, protects the bulb end which is exposed in the corrosive oven atmosphere and thus insures a long trouble-free life.

This process, developed by Standard Steel Spring Company of Coraopolis, Pa., is offered to manufacturers of products requiring the utmost in corrosion resistance. The Robertshaw Thermostat Company, which produces thermostats for every type of temperature control, has chosen this coating to apply to its largest production item, namely, the

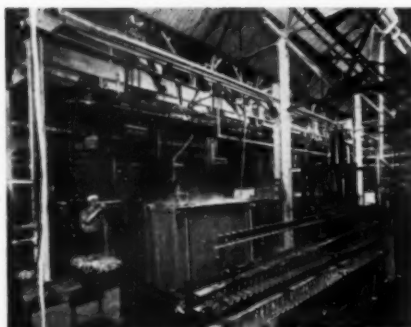


Fig. 1. View of thermostats being placed on the conveying mechanism preparatory to cleaning. Cleaning tank is in center foreground.

Robertshaw oven temperature control, which is in use in millions of homes and is now standard equipment on many products of the leading gas and electric range manufacturers.

The actual thermostat is comprised of two

which operates at the rate of over 1,000,000 parts per year, was made and installed by the Hanson-Van Winkle-Munning Company of Matawan, N. J., manufacturers of electroplating equipment and supplies.

Dual Purpose Degreasers

Phillips Manufacturing Co., 342 W. Huron St., Chicago, Ill., have developed two new dual purpose portable degreasing units, which, because of their portable nature are easily placed in the production line, and shifted about from station to station as the load requires.

In cases where vapor cleaning alone is objectionable because of temperature limits, the use of the new solvent degreasing unit is recommended.

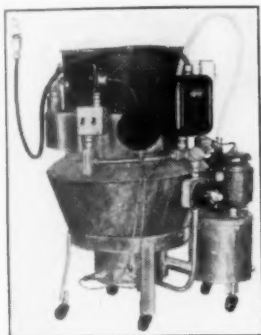


Fig. 1. Dual purpose degreasing unit featuring a low temperature flushing chamber.

The company now presents the model pictured in Fig. 1 (18-2-M.F.), a dual purpose unit, featuring a low temperature fluid solvent flushing chamber, with 16 adjustable nozzles, spraying a predetermined pattern over work up to 15" in diameter by 9" deep, with heat selector switches and an adjustable thermostatic control for temperature ranges between 135° and 200° F., and transposed by the flick of a cut-over control to a straight vapor degreaser using the company's solvent with a vapor temperature of 249° F. This phase is also thermostatically controlled, and further protected by a high temperature cut-out.

For the removal of smut and oxides, it is sometimes necessary to first degrease the work and then subject the work to a cleaning bath of alkali or one of the many late improved caustic or organic cleaners. For this adaptation, the company has introduced the

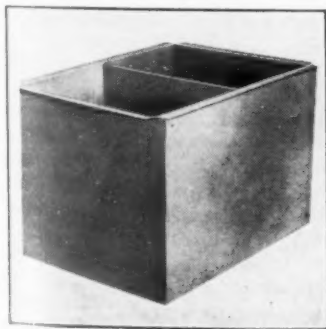


Fig. 2. View of 36" insert tank for alkali cleaning.

... at the ASTE SHOW, see HAMMOND'S NEW VARIABLE SPEED LATHE



SPEED CHANGES
1500-3000 RPM
"THE DIAL DOES IT"

- ★ OVERHANGING SPINDLE
- ★ CONSTANT SPEED—UNIFORM FINISH
- ★ ONE MACHINE GIVES YOU

POLISHING • BUFFING • AND COLOR BUFFING
IF YOU CAN'T BE THERE, WIRE OR PHONE FOR INFORMATION

See You at ASTE

BOOTH 154

Hammond Machinery Builders
INCORPORATED
KALAMAZOO, MICHIGAN, U.S.A.

1601 DOUGLAS AVE.

ASK ABOUT HAMMOND'S MODERN AUTOMATIC LINE

Model 36-insert tank (Fig. 2), which, as its name implies, is merely inserted into a Model 36 Phill-Co degreaser, one compartment then being filled with the cleaning solution; the other with rinse water.

The heat of the solvent vapors keeps the alkali or other bath at a constant temperature through contact with the double wall of the insert tank, thus permitting vapor degreasing and alkali cleaning in one unit.

The portable degreasing units are self-contained, with built-in stills. They require no water, steam or gas connections—only electrical outlets. This portability is said to be important to low operating cost and adaptability for almost any kind of work.

The degreasers are 100% electrically heated and controlled. They are especially designed for the use of "Phillsolv", a chlorinated hydrocarbon solvent which boils at 249° F. The vapors, condensing on contact with the metal parts to be cleaned, flush off the

grease, cutting or grinding oils.

"Phillsolv", with its high boiling point, is claimed to allow the work to absorb 68.5% more flushing action, over and above trichlorethylene. Other claimed advantages of the solvent include greater heat capacity on a weight basis, which is highly important in vapor degreasing, also its heavier weight, 5½ times heavier than air, 9.5% heavier than trichlorethylene. The heavier liquid drains more quickly and completely than the lighter one.

The degreasers are made in three sizes which are standard models. They have solvent capacities ranging from 3 gallons to 20 gallons, and turn out from one ton a day to a ton an hour. They can be wired for practically any electrical specification.

The Phillips Manufacturing Company offers engineering, laboratory and field counseling service, covering any metal cleaning problem, without cost or obligation.

CHROMIC ACID

99.75% PURE

Stocks of Mutual Chromic Acid are available in all principal industrial centers, where Mutual distributors stand ready to give complete technical service supplemented and supported by the research and development facilities of the world's largest manufacturer of chromium chemicals.

BICHROMATE OF SODA
BICHROMATE OF POTASH



Mutual Chemical Co. of America

270 MADISON AVENUE, NEW YORK

New Plastic and Metal Adhesives

Two adhesive solutions made of "Vinylite" resins, and which produce unusually strong, impact-resistant, metal-to-metal or phenolic-to-phenolic bonds, have been developed. They are thermoplastic cementing agents and can be used for assembling either molded or laminated phenolic materials.

These adhesives are designated as "XL-5041" and "XL-5075," the former being a 24.5 per cent solution of a modified polyvinyl acetate in toluol and the latter, a 28 per cent solution of the same resinous material in methyl acetate. Both produce the same strong bonds, and the choice of which to use depends only upon the speed of drying required, the XL-5075 adhesive drying considerably faster.

In using these new adhesives on molded phenolic plastics, the surface of the molded part is first cleaned by washing with ethanol or toluol and the thinned adhesive solution is roll-coated or sprayed on either one or

both of the surfaces to be joined. For adhesion, the parts are placed in position in a jig, pressure is applied, and the assembly is heated, cooled under pressure, and the bonded parts are released.

For bonding laminated phenolics to each other, to molded phenolics, or to metal, the same general procedure is used. The modified polyvinyl acetate adhesives can only be used, however, after the phenolic bond of the laminate has been cured. Partial curing during adhesion or a combination of the curing and thermoplastic fusion processes does not result in satisfactory results. If curing has been completed, however, excellent adhesion is secured readily.

The bond strength of the new "Vinylite" adhesives is remarkably high. Tension tests of metal samples bonded indicate a shear strength of the order of 6,000 lb. per sq. inch. In addition, the impact strength is better than that obtainable with regular grades of polyvinyl acetate, parts bonded with the modified adhesives being able to withstand

sharp blows without injury.

Technical literature on these new adhesives is available from the Plastics Division of Carbide and Carbon Chemicals Corporation, 30 E. 42nd St., New York.

New Foundry Gun

Binks Manufacturing Co., 3114-40 Carroll Ave., Chicago, Ill., announces that a new foundry gun has been developed to meet the demand in the foundry industry. This gun is intended for spraying of molds with the various compounds used in foundries. The gun is of the siphon type and has no fluid valve incorporated in it. It is simple and sturdy, built to withstand the extreme abuse that it will receive in the ordinary foundry. There are two models: 34F-1, in



Gun for spraying foundry molds.

which the material comes on the outside and the air on the inside nozzle. This is claimed to be a very fast gun and can be used very successfully on large molds: 34F-2, in which the material comes through the center and the air through the outside nozzle. This gun, it is reported, will give a finer and better atomized spray, to be used on small molds where the finish must be more carefully watched.

It is recommended that the customer use an ordinary steel or wooden pail, depending upon the liquid to be used. Ordinarily a $\frac{3}{8}$ " material hose, six feet long with one connection, is satisfactory.

New Paint for Highly Corrosive Conditions

A new grade of Koroseal paint, named "Koroplate" developed to protect metal surfaces against chemical reactions and recommended for service wherever extremely corrosive conditions disqualify any other kind of paint or coating is announced by The B. F. Goodrich Company, Akron, Ohio.

Base of the paint is Koroseal, a synthetic material created in the Goodrich laboratories from polyvinyl chloride, which is derived by a series of chemical reactions from the common materials, coke, limestone and salt.

The new paint is liquid at room temperatures and requires no heating before application. At ordinary temperatures it can be either brushed or sprayed, and can be thinned with either brush or spray thinners when necessary. It is made only in semi-glossy black.

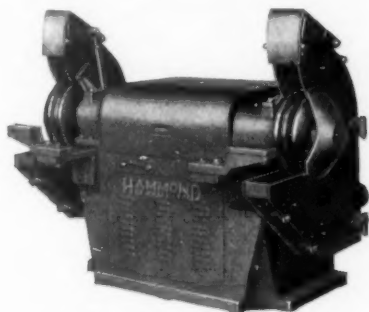
It must be used in conjunction with a Koroseal primer with similar characteristics.

The new paint when thoroughly dry is extremely resistant to the action of fumes and vapors from acids, alkalis and salts at room temperatures or slightly above. It resists all acids except concentrated formic and acetic, and is not affected by brass, chromium, nickel, cadmium, zinc, copper, silver or tin plating solutions. Such solutions are not contaminated or fouled by the thoroughly dried paint, although it is not recommended for constant immersion in liquids.

Among the uses to which the new paint has been successfully put are application on sour crude storage lines and underground pipe and gathering lines, and for the painting of fume ducts in plating rooms.

New Heavy Duty Multiple Speed Grinder

Hammond Machinery Builders, Inc., 1601 Douglas Ave., Kalamazoo, Mich., have announced a new addition to their line of grinding and polishing machinery. The addition is their type "WR" 30-inch heavy duty grinder with multiple speeds.



Heavy duty multiple speed grinder.

This grinder will accommodate up to 30" diameter wheels and will also take a 25 H.P. motor. A multi-V belt drive is employed. The grinder is built oversize throughout and is designed especially for extra heavy grinding applications.

Commutator and Ring Burnishing Tool

The Ohio Carbon Co., 12508 Berea Road, Cleveland, Ohio, have developed a burnishing tool, as illustrated, for the burnishing of commutators. The treatment consists of merely holding the burnisher firmly against the commutator until the film or glaze, which is present, is removed. It is said that there is no dusting and the slots do not fill up, and due to its resilient qualities, the burnisher, in many cases, pulls out material already deposited in slots.

The burnisher is not a commutator stone as it has no cutting action and, therefore, it will not reduce high mica, flat or burned spots. The burnisher polishes to a perfect face removing only the surface film. The



Commutator burnishing tool.

Modernize Your Pickling Processes With

ENTHONE ACID ADDITION AGENT

Enthone Acid Addition Agent is a unique surface tension depressant used in hot or cold sulfuric or muriatic acid pickles. Extensive laboratory tests and many industrial users have shown that with the use of ENTHONE AAA the following results are obtained:

- ★ **FASTER PICKLING**—the acid rapidly penetrates under rust and scale, thus lifting them off!
- ★ **LESSENS FUMES**—the attack of acid on bare steel is reduced at least 75%! Less gas to cause harmful fumes!
- ★ **SAVES ACID**—Drag-out is materially reduced and acid is saved by inhibiting action!
- ★ **OVERCOMES WATER-BREAK IN PICKLING**—Due to poor alkaline cleaning or soap in the alkaline cleaner, water-breaks appear on acid dipping before plating. The use of ENTHONE AAA in the acid literally makes the acid a cleaner and overcomes peeling due to faulty cleaning.
- ★ **FASTER STRIPPING OF HEAVY CHROMIUM**—The use of ENTHONE AAA in muriatic acid greatly increases the stripping action on faulty hard chromium and eliminates attack on steel die.
- ★ **FOR STRIPPING ZINC OR CADMIUM FROM PLATING CYLINDERS**—ENTHONE AAA used in acid for stripping zinc or cadmium from plating cylinders will speed the stripping. The acid will penetrate every recess to remove metal causing disintegration of the cylinder. Attack on steel tie-rods is eliminated.

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AND FREE SAMPLE

The **ENTHONE Co.**

NEW HAVEN, CONN.

Chemical Products



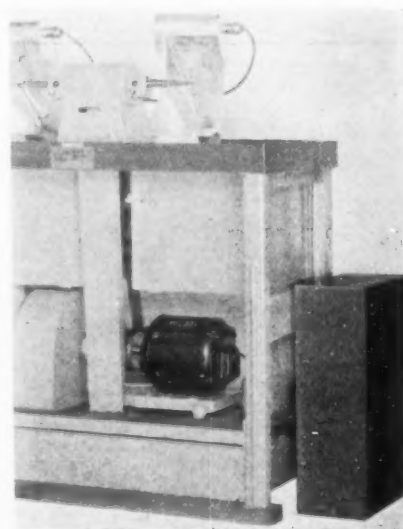
clean, smooth surface obtained is said to result in better performance, in reduction of sparking, and in more uniformly distributed contact drop. In addition, because of the intimate contact, better commutation with reduction in uneven brush wear is reported.

The burnishers are available in various sizes and with various length handles.

New Dust Collector Air Filter

Leiman Bros., 101-H-5 Christie St., Newark, N. J., have developed a new auxiliary dust filter for use with the company's polishing dust collecting outfits and at the outlet of their cyclone dust tanks or other dust collecting systems.

The dust filter is stated to insure clear air as it emerges from the machine and the air is blown either into the room or out-of-doors. The filters are made in sizes as may be required, and contain spun glass filter pads through which the air must travel before



Air filter for dust collectors.

When BEST it's FELT



Companies that make their product look worth the difference to the buyer use *Paramount Brand Felt Polishing Wheels* to polish the base metal, knowing that to have the best finish, you must start right, which means, *Paramount Felt Polishing Wheels*.

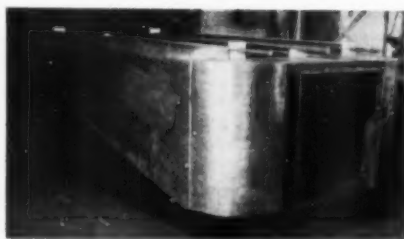
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STEAM JETS



COIL HEATING



ELECTRIC



GAS HEATER



JACKET TANK

Nozzle for producing a simple flat spray.

Standard stock construction is brass, and all iron. Other materials can be specified. The nozzles are to be used for processing, and industrial washing machines, where sprays are overlapping each other.

Manufacturers' Literature

Commutator Burnisher. The Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio, have published a 4-page folder describing and illustrating their burnisher, which is used for removing the film or glaze from commutators. The treatment consists of simply holding the burnisher firmly against the commutator until the film or glaze is removed. Specifications and prices for the various sizes of burnishers are given.

Filters for Plating Solutions. Alsop Engineering Corp., Milldale, Conn., have issued an eight-page catalog, No. P-40, in which are described and illustrated the company's sealed disc type filters. Phantom drawings and sketches show the treatment and operation principles. A portion of the filter discs used is included in the catalog.

Lining and Protective Material. U. S. Stoneware Co., 60 E. 42nd St., New York, have just published an illustrated 8-page bulletin No. 1610, giving the story of "Tygon" a modified halide polymer that is used as a lining material for tanks and as a protective material for plating equipment, such as racks and carrier arms. The lining is resistant to practically all organic and inorganic acids with the exception of glacial acetic and fuming nitric acid. The

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company's "Tygon" paint is also described in the bulletin and the various colors available are shown.

Liquid Level Gauges. Catalog No. 1015, just issued by The Bristol Co., Waterbury, Conn., describes float, pressure bulb, pressure and other various type water and liquid level gauges. Types of applications of these instruments are given, including the measurement and automatic control of liquids in open, as well as in closed vessels where the surface of the liquid is under static pressure.

Mixing Equipment. The Eastern Engineering Co., 45 Fox St., New Haven, Conn., announce a new 24-page catalog describing and illustrating mixing equipment for industrial applications. One section of this catalog is devoted to engineering data on the selection and adoption of mixing machinery. The catalog includes descriptions and illustrations of electrical fluid mixers of various sizes and types. Another section is devoted to special related items in fluid handling, such as pumps, air powered mixers and temperature controls.

Pre-Finished Metals. "Speed Up" is the title of a 4-page folder published by the American Nickeloid Co., Peru, Ill., describing and illustrating the use of pre-finished metals in the National Defense Program.

Remote Transmission. Catalog No. 9400 just issued by the Brown Instrument Co., Philadelphia, Pa., gives information on the applications of their remote transmission equipment. The uses include indicating, recording and control of temperature, pressure, flow and liquid level in hazardous atmospheres where the use of electrical transmission is not desirable nor permissible. Operating features and the construction of the remote transmission are described.

Sparks from Grinding. Norton Co., Worcester, Mass., have just issued literature giving pictures illustrating the types of sparks obtained on grinding various types of ferrous alloys. Spark patterns are of value in determining the type of alloy or steel under investigation. The characteristic spark patterns of various alloys are described as well as illustrated.

Stainless Steel Fabrication. Allegheny Ludlum Steel Corp., Pittsburgh, Pa., have just published a 30-page folder describing the fabrication of their stainless steels. Various processes discussed include welding, drawing and blanking, machining, spinning, upsetting and forging, riveting, shearing, soldering and brazing, annealing and heat treatment, grinding, polishing and buffing, surface treatment.

Temperature Control. Sterling, Inc., 3732 N. Holton St., Milwaukee, Wis., in their bulletin No. 402, describe their No. 150-A self contained, self operated temperature control for use on tanks and processes. The bulletin gives typical applications, installation instructions and capacity data.

Welding Alloys. The Weldoloy Mfg. Co.,

Right Down Your Alley!



If you are cleaning non-ferrous stampings or castings (aluminum alloy, magnesium alloy, copper and brass) during processing, cleaning between drawing operations, after drawing and before annealing, investigate Wyandotte MK-50 Solvent Detergent for use in metal-parts washing machines.

MK-50 is seldom used at

greater strength than one gallon in 500 gallons of water.

Wyandotte MK-50 Solvent Detergent also is used in metal-parts washing machine cleaning before painting, lacquering or enameling.

Your Wyandotte Representative will be glad to give you more information. Write us.



Service Representatives in 88 Cities

THE J. B. FORD SALES CO., WYANDOTTE, MICHIGAN

3 Park Place, New York, have just published a folder describing and illustrating various welding alloys for cast iron, steel, bronze, white metal and aluminum.

General Motors Corp., will address the Branch on Friday evening, March 7th, and on April 4th, the speaker will be Dr. Charles L. Faust, Battelle Memorial Institute.

Subjects of both speakers are to be announced later.

Associations and Societies

American Electroplaters' Society

Detroit Branch

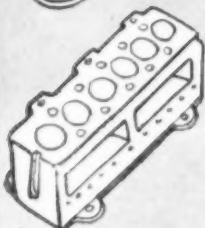
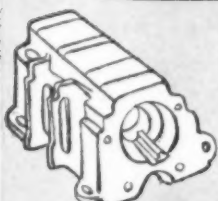
R. M. Wagner, Guide Lamp Division,

**Los Angeles Branch
Annual Meeting**

In contrast to the 1940 session, when such speakers as Dr. William Blum, Oscar E. Servis and Frank Hanlon lent a national tinge to the program, the 1941 Annual Educational Session of Los Angeles Branch, A.E.S., to be held at the Los Angeles Break-

COWLES SM CLEANER

• FOR CHEMICALLY CLEAN METAL



• **H**ERE is a steel and iron casting cleaner that is designed to meet your cleaning requirements. SM CLEANER is a non-foaming heavy duty material that is recommended for use in high pressure automatic metal washing machines.

SM CLEANER is a fast acting, free rinsing cleaner that is used successfully in steam guns and in still tanks where speed is a factor.

For efficient, economical cleaning, investigate COWLES SM CLEANER. A Cowles representative will be pleased to give you further information.

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THE COWLES DETERGENT COMPANY

Metal Cleaner Department

7016 EUCLID AVENUE • CLEVELAND, OHIO

"Cleaner Surfaces for Better Finishes"

fast Club on March 22, will feature an all-California speakers' program.

The tentative program has been announced as follows:

"Plating Operations at the General Electric Plant at Ontario, Calif., with a Discussion of Oil Spotting," a paper prepared jointly by *Frederick Maurer* and *Gilbert Extale*.

"Alloy Steel," by *Albert G. Zima*, technical adviser, International Nickel Co., Los Angeles.

"Some Aspects of Bright Nickel Plating," by *Harold J. Kroesche* of A. J. Lynch Co., Los Angeles.

"Principles of Detergency," by *Dr. T. K. Cleveland* of the San Francisco Division, Philadelphia Quartz Co.

"Anodizing of Aluminum Alloys," by *Paul P. Mozley*, materials and process engineer, Lockheed Aircraft Corp., Burbank, Calif.

"Care and Maintenance of Vapor Degreasers," by *O. B. Moe*, sales engineer, G. S. Blakeslee & Co. of Chicago.

"Synthetic Lacquer in Plating," by *Milton M. Loeserman*, resident engineer, Pabco Re-

search Laboratory Division of Paraffin Co., Inc.

There will also be presented a paper by *D. N. Eldred* of the E. I. DuPont de Nemours & Co., Inc., Pacific Division, El Monte, Calif., dealing with a still unannounced subject.

An added feature will be a Bureau of Mines film, "Copper and Brass Fabrication."

The Los Angeles Breakfast Club will lend itself to a more comprehensive exhibit of electroplated products than was possible in the limited space available at the Hollywood Hotel in 1940. For this reason plans are being made for a considerably larger exhibit of plating supplies and samples of plating finishes than was possible last year.

Newark Branch

Annual Meeting

The annual educational session and banquet will be held Saturday, April 26th at the Hotel Robert Treat, Park Place, Newark, N. J.

The educational session will start at 2:30

P.M., with the following speakers and subjects:

1. *Dr. Walter R. Meyer*, Editor, Metal Finishing. "Engineering Aspects of Electroplating."

2. *George B. Hogaboom*, Engineer, Hanson-Van Winkle-Munning Co., Matawan, N. J. "Design for Finishing."

3. *H. E. Haring*, Bell Telephone Laboratories. "Corrosion."

4. *Floyd Oplinger*, Assistant Manager, Electroplating Div., E. I. duPont de Nemours & Co., Niagara Falls, N. Y. "Tin Plating and Its Application."

The speakers and their subjects were selected to emphasize the importance of plating to the Defense Program. Other technical societies have been invited to attend the meeting.

A dinner and dance will be held in the evening with a top notch floor show.

The speaker at the regular monthly meeting to be held on March 21st at the Hotel Douglas at 8:00 P.M. will be *L. W. Reinken*, engineer and vice-president, W. Green Electric Co., New York. He will discuss the "Development and Applications of Rectifiers."

New York Branch

Annual Meeting a Great Success

The annual meeting of the Branch, held Saturday, February 22nd and termed the "Diamond Jubilee" in honor of the 75th birthday of *Charles H. Proctor*, founder of the American Electroplaters' Society, was the most successful ever held by the Branch, in consideration of attendance and enthusiasm shown by those present.

The educational session was attended by over 200 members of the Society, with *Edwin C. Rinker*, Oakite Products, Inc., as technical chairman. *Frederick Fulforth* of Philadelphia, and president of the A.E.S., first addressed the meeting and spoke of the enthusiasm of the Los Angeles Branch as noted at his recent visit to California. He also spoke of the advantages of membership in the A.E.S. *W. J. R. Kennedy*, executive secretary of the Society, then spoke on the development of the A.E.S., and paid tribute to *Charles H. Proctor*. *Joe Barron*, chairman of the National Annual Convention to be held in Boston in June, spoke to the members inviting them to the convention.

Following these speakers, the formal educational program was presented.

The first talk was presented by *Harold M. Lang*, chemist, Sigmund Cohn, Inc., New York, who discussed the development of electrolytic polishing. He described the solutions used in electrolytic polishing and its many applications; samples of electrolytic polished work were shown.

Dr. Louis Weisberg, New York City, described a new complex amine bright copper plating bath. An interesting discussion followed *Dr. Weisberg's* talk.

The third speaker was *Martin M. Maher, Jr.*, Etched Products Corp., L. I. City, who gave a report on an interesting study of

the effects of variations in the pH of copper plating solutions on blistering of plated zinc base die castings. He found, for example, that blistering occurred in the high pH region, and dropped successively until a pH of 9.4 was reached, at which pH a minimum of blistering occurred. An extensive discussion also followed Mr. Maher's talk.

The final speaker on the program was Ellsworth Candee, American Brass Company, Waterbury, Conn., and first vice-president of the Society. He discussed plating at the Metal Hose Branch of the American Brass Company, and showed a movie depicting the mining and refining of copper and the fabrication of copper and its alloys.

The dinner and dance was held in the Madhattan Room of the Hotel Pennsylvania, which lent a beautiful atmosphere to the meeting. Following an excellent dinner, a highly talented show was presented with professional actors from the Paramount Theatre in New York City.

To illustrate the cooperative spirit of the Branch, over fifty door prizes were awarded.

Over 300 people were in attendance at the dinner, and a large percentage of the people stayed until the curfew at 1 A.M.

The committee is to be particularly congratulated for the excellence of the entire meeting and for the careful attention to every detail.

Electrochemical Society

The 79th convention of the Society will be held at Cleveland, Ohio, April 16-19. The headquarters will be the Hotel Cleveland, and R. S. Mackie is chairman.

The following tentative program has been drawn up:

Wednesday, April 16

7:00-10:00 p.m. Registration.
8:30 p.m. Board Meeting.

Thursday, April 17

7:30 a.m. Group Breakfasts (in charge of Divisions).
8:30 a.m. Registration continued. Mezzanine. Fee \$2.00.
9:00 a.m. Session on "Irreversible Electrode Processes." Dr. S. Gladstone of Princeton University, presiding.
12:00 noon. Luncheon at the Hotel Cleveland. Luncheon speaker Dr. W. E. Wickenden.

1:15 p.m. Leave for Nela Park Laboratories and Pitney Bulb Factory.
7:00 p.m. Reception to the newly elected President.
7:30 p.m. Banquet. Award of Fellowship and Prize to Young Author. Presidential address.

Friday, April 18

7:30 a.m. Group Breakfasts (in charge of Divisions).
8:00 a.m. Registration continued. Mezzanine. Fee \$2.00.
9:00 a.m. Session on "High Frequency Electrothermics." P. H. Brace, Westinghouse Electric & Manufacturing Co., in charge.
12:00 noon. Luncheon at the Hotel Cleveland.

METAL FINISHING, March, 1941

STILL GOOD after handling 10,000 TONS of Nuts and Bolts...

Record made by this type of basket proves Monel-equipped Pickling Room is no bottle neck

One sure way to speed pickling room production is by using Monel equipment. Proof? Consider the experience of United Platers, Inc. of Detroit:

Because inferior equipment caused loss of production, United changed to Monel for pickling baskets. Result: Eight have handled 10,000 tons of nuts, bolts, washers, and are still in good condition.

Today, in the pickling room, you want no breakdowns but faster production. Strong, lightweight equipment of Monel is the answer. Write for full information on how to get it. Address:

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MONEL

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

Monel dipping baskets made by Naum Saba, 2266 E. Congress, Detroit, for United Platers, Inc., 944 Madison St., Detroit. Eight similar baskets still good after handling 10,000 tons of nuts, bolts and washers.



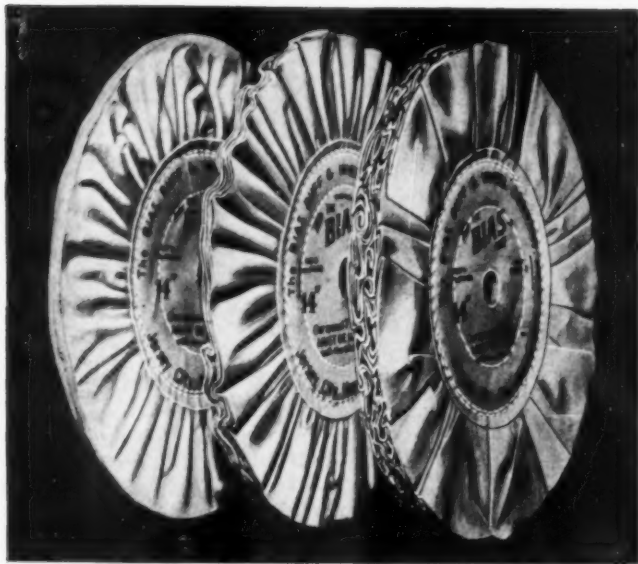
land. Luncheon speaker D. Mathew Luckiesh. W. G. Harvey, toastmaster.
1:15 p.m. Leave for plant trip.
7:30 p.m. Supper and Entertainment, including dancing, in charge of J. H. Winkler.

Saturday, April 19

7:30 a.m. Group Breakfasts (in charge of Divisions).
8:00 a.m. Registration continued. Mezzanine. Fee \$1.00.
9:00 a.m. Session on "Chemical Action in Electric Discharge." M. E. Fogle of Weston Electrical Co. in charge.
12:00 noon. Luncheon at the Hotel Cleveland. Luncheon speaker, Major John Berry.
1:15 p.m. Leave for trip to Industrial Rayon Plant.
5:00 p.m. Adjournment.

The following papers have been accepted for presentation at the Cleveland Meeting:

"Semi-Conductor Photocells and Rectifiers," by Colin G. Fink and Edward Adler.
"The Electrolytic Reduction of Methyl Ethyl Ketone to sec-Butyl Alcohol and n-Butane," by Sherlock Swann, R. W. Benoliel, L. R. Lyons and W. H. Pahl.
"Structure and Grain Size of Electrodeposited Copper," by Allison Butts and Vittorio De Nora.
"Irreversible Electrode Phenomena of Thallium. 2. Cathode Potential in Ti_2SO_4 Solution," by I. M. LeBaron and A. R. Choppin.
"High - Temperature Metallic Resistor-Furnaces," by W. Kroll.
"The Photovoltaic Effect," by Colin G. Fink and Edward Adler.
"The Constitution and Properties of Cyanide Plating," by M. R. Thompson.
"Investigation of Lead Anodes in the Electrolysis of Zinc Sulfate Solutions," by A. E. Koenig, J. U. MacEwan, and E. C. Larsen.
"The Effect of Silver (0.05-0.15%) on Some



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Twenty years ago the cry went up for a buff that would not ravel or waste cloth when used, yet be reasonable in cost. The BIAS Buff was designed, made, tested and met every requirement. Then a buff was wanted that would do more work with fewer sections. Again the BIAS Buff solved the problem with Type "A" Buff shown above which did 50 per cent more work with 50 per cent fewer sections than any ordinary buff made. Once more a buff was wanted for heavier work; it must have a hard face. BIAS Type "K" was offered and it is 100 per cent right for its job. BIAS Buffs now have the ventilated feature. There is a BIAS Buff for every polishing job—and when better Buffs are made BIAS will make them. Ask any user of BIAS Buffs. Send for a trial order.

WARNING NOTICE: The Bias Buff & Wheel Co., Inc. is located at the Jackson Buff Corporation of Long Island City, New York, with full rights to manufacture under U. S. Patents No. 19,874 and No. 2,140,206 which have broad claims covering an air-circulated buff having means for the admission of cooling air through the sides of the buff. Manufacturers of buffs are warned against infringement of the claims of these patents as the owners and the licensee intend to protect their rights under these patents and stop infringement. Also U. S. Patent 2,096,421

The BIAS BUFF and WHEEL CO., Inc.
430 Communipaw Ave. Jersey City, N. J.

Properties and the Performance of Antimonial Lead Storage Battery Grids," by Colin G. Fink and A. J. Dornblatt.

"The Effect of Gas Pressure on the Passivity of Iron," by R. S. Crog and Herschel Hunt.

"Formation of Anodic Coatings on Aluminum," J. D. Edwards and F. Keller.

"Silver Plating Baths Containing Amines," by L. I. Gilbertson and F. C. Mathers.

"The Efficiency of Sodium Chlorate Cell with Rod Cathodes," by J. McLaren, J. Turer, F. H. Davis, A. L. Pitman, P. H. Groggins.

"Indium Plating," by Henry B. Linford.

"The Rate of Film Formation on Metals," by Benjamin Lustman.

"The Potential of Iron-Chromium Alloys Containing Hydrogen," by H. H. Uhlig, N. E. Carr and P. H. Schneider.

"Studies of Electrochemical Polarization," by A. E. Lorch.

The Phantom Guest

According to plans arranged by our Supreme President, Frederick Fulforth, F. A. Maurer was to be his dinner guest upon arrival here (Los Angeles) Sunday afternoon, January 26, and Ernie Lamoureux had been invited to join them at the festive table. However, instead the latter had arranged a different plan whereby President Don Bedwell, his wife and charming daughter Lorraine, Mr. and Mrs. M. P. Rynkofs, Mr. and Mrs. C. E. Thornton, and Mr. and Mrs. Lamoureux were to gather at the Roosevelt Hotel in Hollywood, and Mr. and Mrs. F. A. Maurer were to meet Mr. Fulforth at the airport and join the above in a surprise reception dinner at the habitat of the movie stars.

And about the time the appetites were on the uptrend, all hopes of the culinary treat were shattered by a telegram saying, "All planes grounded at Chicago. Wiring new plans later."

For a time the whereabouts of our phantom guest were unknown, he apparently being lost in the clouds or buried in the snows of the Middle West. On Tuesday, January 28, Mr. Maurer got word that he was hibernating with the Indians who weave blankets at Albuquerque, New Mexico, seemingly thawing out from the snows and frost, and that he would arrive at Union Airport, Los Angeles, at 4:51, or as soon as he could get free of the Indians, anyway.

Learning that Mr. Maurer would not be able to come in (from Ontario, Calif.) to meet him, Ernie arranged to meet what the Indians sent us at the airport in company with the Rynkofs and Mrs. Lamoureux, and drive direct to Ontario, Calif., to be joined by the Maurers and dinner at Padua Hills, a quaint and highly excellent place to dine near Ontario.

None of us had any lunch at noon. When Ernie called the Rynkofs, Marcus had a bottle of milk in his hand, and when informed of the plan, he immediately threw it out of the window, and naturally. With Padua Hills in prospect as a place to eat, it is not uncommon for people to refrain from eating all day. And we were all in high glee, when out of a clear sky came—not our prospective guest—but another message, saying: "All Planes Grounded again." This wire being from Albuquerque, we naturally figured Fred had taken a liking for some Indian princess, "What else?" and could not tear himself away.

And Ernie again had the sad news of breaking the bad news to the gang, and there was an immediate slump from the prospective heights of the Padua Hills cuisine to the hot-dog stands, locally to appease the inner man who had twice been cheated out of dinner.

What to do now? Having again lost contact with our phantom guest, when another message arrives saying, "Will arrive Los Angeles on California Limited 10:40 A.M. Wednesday."

This gives us an idea to catch up with that elusive dinner. . . . A reception committee, meet the train, escort our guest of honor, and dinner at noon!

Ernie is reaching for the phone to round up a committee when a messenger rings the door bell. Yes, you guessed it! No dinner! The telegram said: "Detraining Upland for Ontario—Arrive Los Angeles with Maurer for special meeting."

—Ye Phantom Chaser.

Obituaries

John T. Ryan

John T. Ryan, 57, President of Mine Safety Appliances Company, Pittsburgh, died Feb. 20 in Miami, Florida.

Mr. Ryan was a native of Huntingdon County, Pennsylvania—attended Juniata College and the Pennsylvania State College from which he graduated in 1908 with a B. S. Degree in Mining Engineering. In 1934 he was given the degree of Honorary Engineer of Mines by the same institution.

During his entire business life he was

actively identified with the mining industry. After graduation he became affiliated with the Rocky Ridge Coal Company and later was Superintendent and Mining Engineer for Langdon Coal Company of Huntingdon, Pennsylvania.

From 1911 to 1914 he was in charge of the mine rescue and safety, and mine lamp testing division of the United States Bureau of Mines. In 1914 seeing the need for more adequate safety equipment, he and George H. Deike of Pittsburgh, founded the Mine Safety Appliances Company, which today is the largest manufacturer of mining and industrial safety equipment in the world.

In 1915 Mr. Ryan worked with Thomas A. Edison in the inventor's laboratory at West Orange, New Jersey, on the design and development of the Edison Safety Cap Lamp, which is so universally used today in underground Coal and Metal Mines throughout the world.

In December, 1940, he was made an Honorary Member of the Edison "Old Timers' Club" comprised of the men who worked with the late inventor in his early years.

Ryan was a member of the American Institute of Mining and Metallurgical Engineers, of which he was past chairman of the coal division, the Canadian Mining Institute, the Coal Mining Institute of America, the Pittsburgh Coal Mining Institute, the Western Pennsylvania Engineers Society, the Illinois Mining Institute, the West Virginia Mining Institute, the Rocky Mountain Coal Mining Institute, and a charter member of the National Mine Rescue Association. He was also a member of the Duquesne Club, Long Vue Country Club, Pittsburgh Athletic Association and the Sigma Gamma Epsilon Mining Fraternity.

Surviving are his widow, Mrs. Mary Gavin Ryan, a son, John T. Ryan, Jr., two sisters—Miss Ella A. Ryan and Mrs. H. J. McCarthy,—all of Pittsburgh.

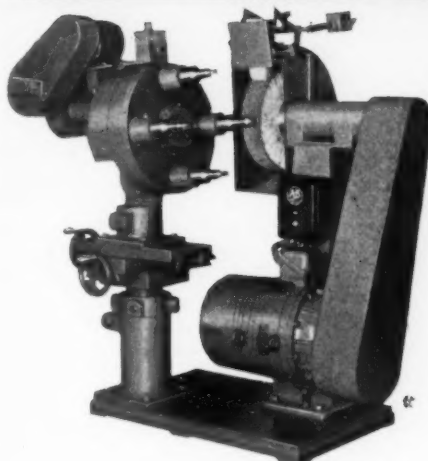
William I. Sivitz

William I. Sivitz, manager of the Pittsburgh office of The Duriron Company of Dayton, Ohio, died suddenly January 30, in Pittsburgh. He had been with the company since 1929. Before that, he was with the Aluminum Corporation of America. Mr. Sivitz was the newly elected president of the Pittsburgh chapter of the American Institute of Chemical Engineers and was a graduate of Carnegie Institute of Technology.

William Trefor Morgan

William Trefor Morgan, chief metallurgist of Taylor Instrument Companies, Rochester, N. Y., died on February 1. Mr. Morgan was born May 27, 1895 in Swansea, Wales. He attended the Swansea Technical College, Sheffield University at Sheffield, England, where he studied under Prof. C. H. Desch, one of the outstanding metallurgists of the world. His academic career was interrupted by the World War, in which he served five years, four of them on active service in France, Egypt and Palestine. After the war, he was associated with R. D. Thomas & Co., in Swansea, then joined the Department of Scientific Research of the British Admiralty, where he spent six years. After coming to

Another "Acme" Combination Unit for Polishing and Buffing!



ACME
SEMI-AUTOMATIC
AND LATHE
COMBINATION
UNIT

**SEND
SAMPLE
for
FREE
Production
Estimate**

It is easy to understand how Acme Automatics speed up production when you stop to consider that the 4-spindle machine illustrated above, for polishing and buffing cylindrical parts, has an indexing range up to 800 indexings per hour, and a still greater speed when equipped with an 8-spindle head.

To meet the demands of present-day production, not only as to speed but also as to low production costs, Acmes are built in a great variety of machine arrangements of universal application, each so designed as to perform its particular job most efficiently. If you have a polishing or buffing problem, we shall be glad to submit suggestions as to how it can be solved.

Acme Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

this country, he was associated with Babcock & Wilcox of Bayonne, N. J., and in 1929, went to the Taylor Instrument Companies. There he assumed charge of the metallurgical laboratory and had served as chief metallurgist ever since. He was a member of the American Institute of Mining & Metallurgical Engineers, the Iron and Steel Institute of Great Britain, American Welding Society, and was a past chairman of the Rochester chapter of the American Society for Metals which he was instrumental in developing.

Mr. Morgan leaves his wife and daughter and his mother and six sisters in England. His death is a severe loss to the company and to his profession.

Edward P. Connell

Edward P. Connell, 56, Secretary-Treasurer and General Manager of the Falk Corporation, Milwaukee, Wisconsin, died Saturday, February 8th, after a short illness.

Mr. Connell had been with the Falk Corporation for 28 years, starting as an accountant in 1913, and later serving as purchasing agent and comptroller. He was appointed treasurer of the firm in 1939, and was named general manager in March, 1940. He was also a director of the company.

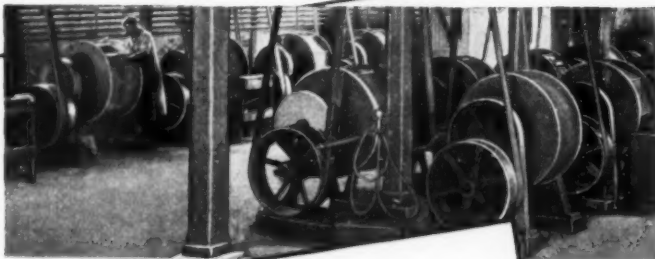
For many years Mr. Connell had been active in the affairs of the American Gear Manufacturers' Association, serving on a number of committees.

Before joining the Falk Corporation, he was connected with the Lake Shore Engineering Company of Marquette, Michigan for 10 years.

Mr. Connell was a familiar and respected figure in the gear industry and his loss will be felt greatly by the many who knew him and worked with him.

As we go to press, we are deeply grieved to learn of the death of Jack D. Tierney, president of Storts Welding Co., 42 Stone St., Meriden, Conn.

Top Speed Production ... at a Profit!



Abbott burnishing barrels are the answer to many a factory manager's search for more efficient finishing methods.

That's especially true in companies that have taken on new items which present unfamiliar problems.

We already have the answer to many of these problems. During the past ten years we have conducted burnishing ex-

periments on all sorts of metal parts.

Take advantage of that experience by putting your problem up to us.

Even if you're not working on new products, you may have some parts now being buffed that could be finished by ball burnishing.

A check-up now may prove to be the first step toward faster production at a fraction of the cost.

The Abbott Ball Company
Hartford, Conn.
1046 New Britain Ave.

Balls
Cones
Pins
Slugs

Quality products for a fine burnished finish

Business Items

Bruce Products Corp. Announces New Machinery Line

The introduction of a new machinery line, including lathes, platers' machines and generators, recently announced by Bruce Products Corporation, Detroit, Michigan, and an increase in its engineering personnel, mark a further step by the company into all branches of the metal finishing industry, according to A. J. Bruce, President.

"Since the company was organized in 1920, we have continually expanded and developed new products," Bruce reports. "Last year our volume was the largest in the history of the company."

Bruce Products was incorporated in 1920 as a distributor for materials essential to the

painting and varnishing of sheet metal, bodies, fenders and similar products. This was before the advent of cellulose products such as lacquer. Among the company's first volume products were alkaline metal cleaners.

In 1922 Bruce Products Corporation began the manufacture of full disc buffs. Since that time numerous patents have been issued to Bruce employees for new developments in the buffing field, among them the "Cantilever Buff" and "Non-Ridge Wheel," both of which are among the company's current "Best Sellers."

The Bruce Products plant is located at Howell, Michigan, in a modern fully-equipped brick, steel and reinforced concrete plant. A number of additions and alterations since the plant was acquired in 1925 have been necessary to accommodate expanding manufacturing and experimental developments.

"Almost since the founding of the company, we have maintained a laboratory for

the control of raw and finished products and for research developments," Bruce declared.

"Until 1937, the composition field had changed but little since its inception at most 50 years before, the only manufacturing method known to the industry was to pour the heated mixture into individual pans inconvenient to handle. The presence of many air pockets was another annoyance. In an effort to eliminate the air pockets and to improve the size and shape of the old style bar of buffing composition, we began experiments that finally resulted, in 1937, in the introduction of our extruded and vacuumized 'Tri-Vac.' As a result, any grade of buffing composition can be made into a smooth symmetrical bar of any size or shape.

"We were the first producers of water-soluble rust-preventing compound. Metal coatings containing water for rust prevention sounds paradoxical, but it is being done very successfully.

"Our Oil Division began operations shortly after we started the manufacture of buffing compositions, and we have been able to make outstanding improvements in the field of lubricants for heavy drawing operations.

"Bonderizing brought in many cleaning difficulties, resulting particularly from drawing compounds carrying heavy percentages of pigment. We developed and now manufacture the only non-pigment drawing compound that will handle extremely heavy sheet metal draws. Another of our developments is a water-soluble transparent grinding oil that will not gum the wheel or the work," Bruce said.

In commenting on the new machinery line, Bruce declared that "the new line is entirely in keeping with the plan of development of Bruce Products Corporation since its inception and is another step in a series which has marked the growth and expansion of the company and its products."

Bruce Products materials are sold through direct distributor representation in principal cities and through jobbers on the West Coast.

In addition to A. J. Bruce, President, executives of Bruce Products Corporation include, C. R. Renwick, Vice-President; H. J. Breithart, 2nd Vice-President & Sales Mgr.; R. A. Garling, Secretary & Treasurer; A. Urban, Gen'l Plant Mgr.; A. D. Gaskin, Director of Research.

Scientific Control Laboratories, 600 Blue Island Ave., Chicago, Ill., a consulting and testing laboratory for the electroplating and finishing industry, has purchased all the assets of the Electroplaters' Service Laboratories of Chicago.

Feeder-Root, Inc., Hartford, Conn., are constructing a building addition, 100 x 120 ft. Cost close to \$200,000 with equipment.

Sarco Company, Inc., 183 Madison Avenue, New York, N. Y., manufacturers of steam specialties, announce the removal of their head offices, effective March 1, 1941, from the above to: 475 Fifth Avenue, New York, where they will occupy the entire 24th floor.

Eugene Phillips Joins Packer Machine Co.

The Packer Machine Company of Meriden, Conn., manufacturers of automatic polishing and buffing machines, have announced the addition to their staff of *Eugene Phillips* as a sales and service engineer.



Eugene Phillips

Mr. Phillips started his duties with the Packer Machine Company on January 1st, and is available to assist his many friends in the trade in their polishing and buffing problems, a business in which he is very well qualified.

For the past few years Mr. Phillips was associated with The Puritan Company of Waterbury, Conn., manufacturers of buffing compounds, in the capacity of sales manager.

J. M. Cosgrove Joins Bruce Products

A. J. Bruce, President of the Bruce Products Corporation, 5712 12th Street, Detroit, Michigan, has announced the addition of *J. M. Cosgrove* to their staff. Mr. Cosgrove received an A.B. Degree from Manhattan College in New York City, and his technical training at the Massachusetts



J. M. Cosgrove

"RACK INSULATION PERFECT!"

SAY PLATERS

"RACKS SHOW NO SIGN OF BREAKDOWN"

NEW YORK, March 1.—Further enthusiastic accounts of the remarkable protection afforded plating racks by United Chromium's "Unichrome" Rack Coating-W confirm early reports from leading platers.

"Unichrome Rack Coating-W still standing up fine after 11 months use in bright nickel and chromium solutions,"—"No sign of breakdown on any of our nickel plating racks,"—"finest material ever!"—are typical endorsements.

Advantages of this superior rack-coating material are:

1. Withstands boiling cleaners and all plating solutions
2. Tough—withstands wear and tear of handling
3. Contains no ingredients harmful to plating solutions
4. Cuts costs—reduces frequency of re-coatings
5. Easy to apply—"dip and force dry" method

6. Light in color—easy to see how well the rack is covered

7. Any part of rack can be recoated without recoating entire rack.

Write for Bulletin 31

Containing Complete Information—

Platers without rack coating facilities may have their racks coated with "Unichrome" Rack Coating-W by Chromium Corporation of America, 4645 West Chicago Avenue, Chicago, Ill. Belke Manufacturing Company, 947 North Cicero Avenue, Chicago, Ill. or United Chromium, Inc., of Waterbury, Conn.

UNITED CHROMIUM INCORPORATED

51 East 42nd Street, New York, N.Y.
2751 E. Jefferson Ave., Detroit, Mich.
Waterbury, Conn.



Trade Mark
Reg. U. S. Pat. Off.

McKEON'S

"Liquid Sulphur"

Will remove copper from steel, iron, brass, zinc die castings, etc. without destroying finish of bare metal.

Write for free special directions.

SULPHUR PRODUCTS CO.

Greensburg, Pa.

(Beans.—Learn about them at Boston—A.E.S. convention—June 9-10-11-12)

Institute of Technology in electrochemical engineering. His thesis on "Corrosion" was considered worthy of publication as a contribution to the subject from the Rogers Laboratory of Physics of that institution.

On graduation he entered the engineering department of a large eastern company and soon after was placed in charge of process control and development covering such plant problems as drawing, grinding, annealing, and electroplated finishes.

Mr. Cosgrove later accepted a position as chief chemist in one of the large mid-west automotive accessory companies where he remained for a number of years. In this position he worked on plating, polishing and buffing problems. His developments here were widely accepted by the finishing industry.

The period just preceding his new connection with Bruce Products was spent in sales engineering and plant layout covering the metal finishing industry.

Higbies Assume Active McAleer Management

At a recent stockholders meeting of the *McAleer Mfg. Co.*, Detroit manufacturers of automobile polishes, rubbing compounds, and allied chemical products, *Carlton M. Higbie* was elected president, and *Bradley Higbie*, treasurer of the company. Both have been inactively associated with the firm for



Carlton M. Higbie

METALWASH AUTOMATIC MACHINES for Cleaning and Drying Metal Surfaces

The machines illustrated below produce perfectly clean dry surfaces on metal stampings and parts, as they pass through

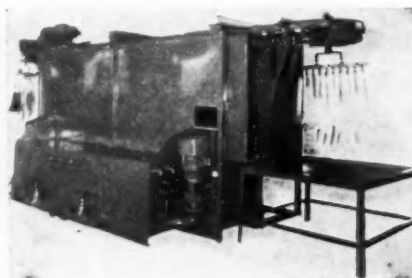


New Model Return Type Machine
Operated by One Man

Parts to be cleaned can be subjected to any series of washing, rinsing, drying, slushing or rustproofing operations without any danger of parts becoming mixed since they are carried in suitable trays.

the varied operations for plating and finishing; also used for the complete removal of lubricants, polishing compounds, grit, dirt, etc., and of any residue that might lodge in crevices or partially hidden parts.

Metalwash machines are used by prominent concerns engaged in Government Defense Work, who are making all types of armament and ammunition components requiring cleaning and treating in the process of manufacturing.

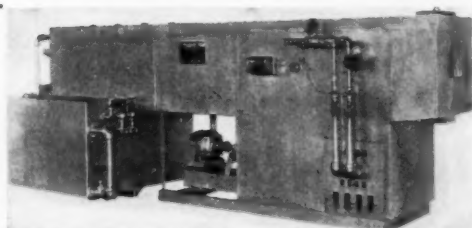


Combination Return Type—
Washing—Rinsing—Drying Machine for Racked Parts

Can also be furnished as separate units. This overhead conveyor type is often used in our Cold and Hot Blast Drying Machine for spotless drying. It is found in many prominent plating plants.

Rotary Drum Type Washing—Rinsing—Drying Machine

Used for washing, rinsing, slushing, drying in any combination of operations. Used extensively by manufacturers of munitions for removal of cutting oil and chips; for cleaning all types of machine parts—either ferrous or non-ferrous metals.



Metalwash machines are designed by experienced engineers. These machines are built for large production. Furnished as complete units or built into your present system. Write for details.

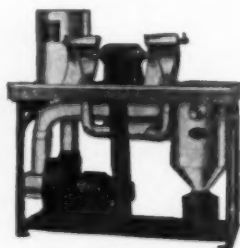
METALWASH MACHINERY Co., Inc.

27-29 Haynes Ave.

Newark, N. J.



Blower



Polishing Bench



Dryer



Tubbing



Sawdust Box



Sandblast

THE BOLAND SYSTEMS

FOR FACTORY INSTALLATIONS
Tanks, Coloring Rooms, Dynamos, Sawdust Boxes

H. J. ASTLE & CO., INC. Established 1884 (Send for Catalogs) 118 Orange St., Providence, Rhode Island

some time, and are now assuming active management of the company.

The Higbies bring to the management of the McAleer Company extensive experience with the manufacture and sale of automotive and industrial products.

Other members elected to the Board of Directors are *Carl Kennedy*, vice-president; *Ernest Hummitch*, secretary; and *Fred Weihe*, production manager. *Arthur Neubauer* continues as manager of the automotive jobber division.

The company has announced an aggressive sales promotion program which embraces a number of new product developments.

Wilfred S. McKeon, president of *Sulphur Products Co.*, Greensburg, Pa., left February 7th for a month or more stay at Kingston, Jamaica. On his way south he stopped in Cuba. Mr. McKeon states that a six-drum shipment of his product "Liquid Sulphur" sent to Birmingham, England, was lost off the coast of Ireland by the sinking of the cargo ship "Ville D'Anvers" (Belgian liner) and former American vessel.

The Virtue Manufacturing Co., 1640 Long Beach Blvd., Los Angeles, Cal., makers of chrome furniture and tubular parts, are currently enlarging their plating room, the third expansion of the plating department during the past five years. A bright nickel tank is being installed. *Phil Virtue* is president; *J. A. Virtue*, general manager, and *M. T. Munnell*, foreman of the plating shop.

Dr. C. L. Mantell, consulting chemical engineer, announces the removal of his office and laboratories from 136 Liberty St., New York, to 601 West 26th St., New York.

F. H. Broughton and *A. J. Domelle*, doing business as the *Allstate Plating Works*, have leased 12,000 sq. ft. in the building at 18-22 E. 24th Street, Chicago, Ill. The owners have been connected with the plating industry for the past twenty years. Their plant is provided with modern equipment for plating and the company specializes in cadmium plating and mechanical barrel plating.

Allstate Plating Works, Inc., Chicago, Ill., organized to manufacture plated metal goods, has leased a floor in a building at 18 East 24th Street, about 12,000 sq. ft. for a plant. *A. J. Domelle* and *F. Broughton* are heads of this firm. The following departments are operated: plating, grinding, polishing, buffing, barrel burnishing, tumbling, pickling, rust proofing, lacquers. The principal base metals used are steel, copper, brass, bronze, aluminum and nickel silver.

H. F. Schotters has been appointed to supervise the distribution of Hobart arc welders in northern Indiana and western Michigan, with headquarters at Koontz-Wagner Electric Co., South Bend, Ind. Local distributors appointed to date include *C. H. Antrim*, Grand Rapids, Mich.; *Hoosier Oxygen Service*, Ft. Wayne, Ind., and *Bingrods, Inc.*, Kalamazoo, Mich.

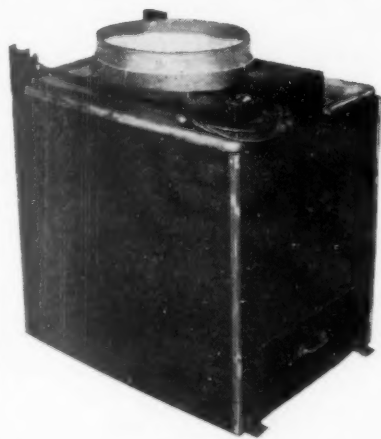
L. F. Supple Joins Reynolds Metals Company to Head Unifoil Division

L. F. Supple, formerly president of the Springfield (Mass.) Glazed Paper Company, has joined the *Reynolds Metals Company* as head of the Unifoil Division. Mr. Supple for thirteen years was affiliated with Whiting, Patterson & Co. of Philadelphia, paper jobbers, for a time being general manager and treasurer of that company. For a number of years Mr. Supple has been prominent in the converting field and in the handling of fancy and decorative papers for packaging. He is widely acquainted in the glazed and fancy paper business, and is well known in the trade for his activities in the National Paper Trade Association. Mr. Supple will make his headquarters at Richmond and New York.

Pal Blade Company Acquires Cutlery Division of Remington Arms

Pal Blade Co., 595 Madison Ave., New York, have announced the acquisition of the entire cutlery division of the Remington Arms Co., Inc., Bridgeport, Conn. The purchase included all machinery, dies, finished goods, goods in process and raw materials, and a new location has been selected in Holyoke, Mass., by the Pal Blade Company, to house equipment and materials so that production will continue without interruption. The cutlery division acquired will be run as a separate division of the Pal business. The Pal Blade Company is reported to be the largest independent razor blade manufacturer in the United States.

ACE SHAKER



For Separating
Sawdust, Balls,
Etc. From Your
Work. Does a
Tedious 3 Min-
ute Hand Job in
20 Secs. and
Does It Better.

Uses Standard 18" Sieve. Produces a Rotary Oscillating Movement—No Dead Spots. No Sawdust or Water Can Get Into Moving Parts.

Order your Ace Shaker now as only a limited number are available due to rush of defense orders. Write:

ACE ENGINEERING & MACHINE CO.
3644 N. Lawrence St. Philadelphia, Pa.

METAL FINISHING, March, 1941

... SPEED UP PRODUCTION

WITH **Rolock**

wire mesh

BASKETS AND CRATES

All Welded Construction

FASTER Drainage—

EASIER Handling—

SAFER Construction—

LONGER Life

Every basket and crate is built to order. . . . Let us help you with intelligent and practical suggestions from years of experience in this field.

Send specifications and production application for specific information.

ROLOCK INC.

18 STATION ST. SOUTHPORT, CONN.

Supply Prices, February 24, 1941

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.			
COPPER: Cast, elliptical, 15" and longer	247% c. per lb.	ZINC: Cast, 99.99, 16" and over	13c. per lb.
Electrolytic, full size, 197% c.; cut to size	197% c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus	
Rolled, oval, straight 15" and longer		cast 47c.; Rolled, depolarized	48c. per lb.
19% c. per lb.; curved	20% c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.
BRASS: Cast, 80-20, elliptical, 15" and longer	23% c. per lb.		

Chemicals

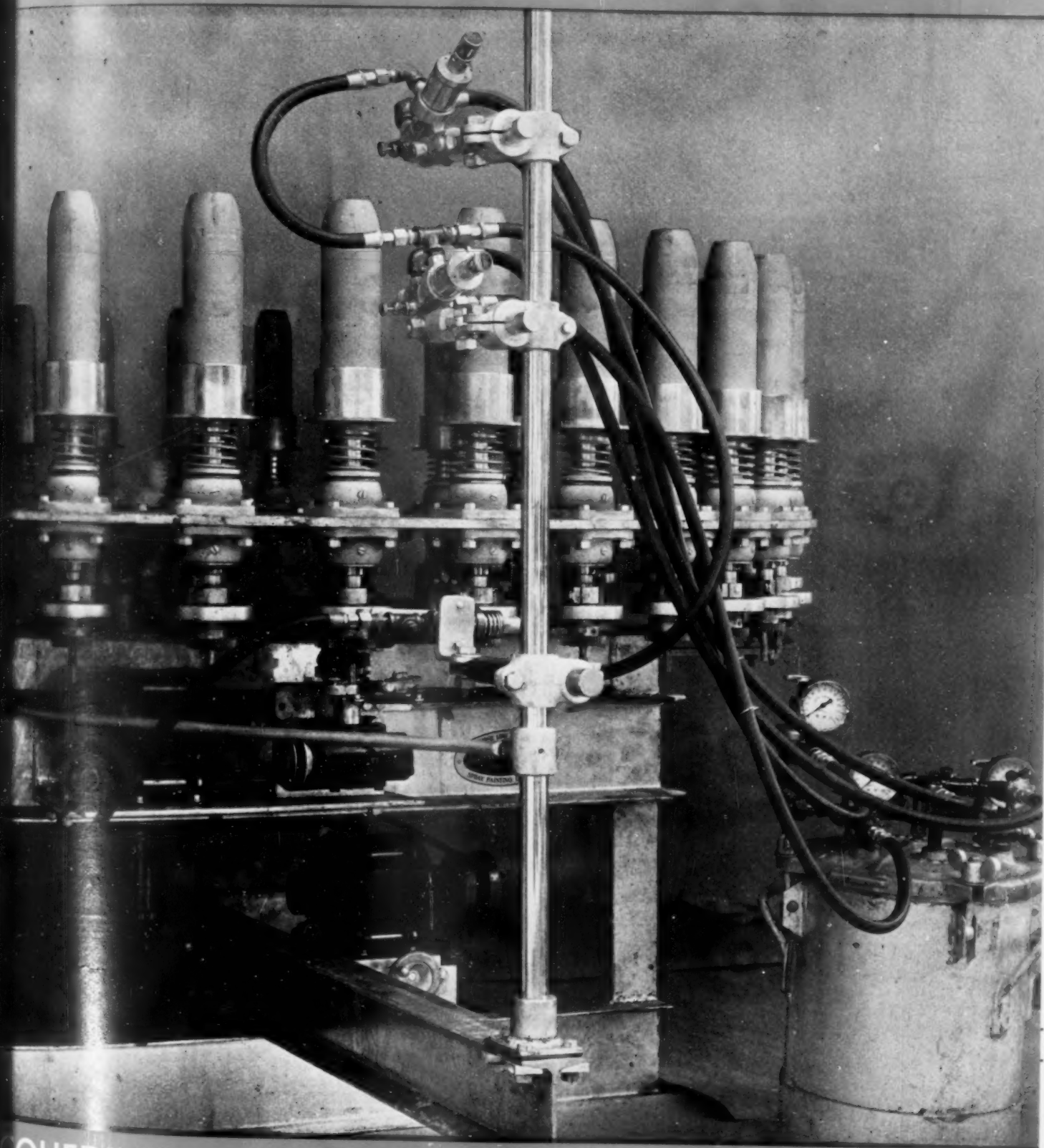
These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.08	Hydrogen Peroxide, 100 volume, carboys	lb.	16-18%
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615	Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Chromic, 99%, 100 lb. and 400 lb. drums, l.c.l.	lb.	.17 1/4	Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.11
Hydrochloric (muriatic) Tech., 20°, carboys, wks.	lb.	.027	Oxide (Litharge), com., powdered, bbls.	lb.	.08
Hydrochloric, C.P., 20°, bottles	lb.	.19	Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Hydrofluoric, 30% bbls.	lb.	.06-.06 1/2	Mercury Bichloride (Corrosive Sublimate), crys.	lb.	\$2.19
Nitric, 36°, carboys 1-9, wks.	lb.	.0595	Mercuric Oxide, tech., red, powder, bbls.	lb.	\$2.81
Nitric, 42°, carboys 1-9, wks.	lb.	.0745	Nickel, Carbonate, dry, bbls.	lb.	36-36 1/2
Oleic (Red Oil), distilled, drums	lb.	.07 1/4-.08 1/4	Chloride, bbls.	lb.	18-20
Oxalic, bbls. l.c.l.	lb.	.14	Salts, single, 425 lb. bbls.	lb.	135-145
Stearic, distilled, double pressed, bags	lb.	.10-.11	Salts, double, 425 lb. bbls.	lb.	135-145
single pressed, bags	lb.	.09 1/2-.10 1/2	Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.067
triple pressed, bags	lb.	.12 1/4-.13 1/4	Perchloroethylene, drums, l.c.l.	lb.	.08 1/2
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245	Phosphorus, red, cases	lb.	.44
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.16-17 1/4	yellow, cases	lb.	23-25
Butyl-normal, l.c.l., drums	lb.	.105	Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.315	Potassium, Bichromate, crystals, casks	lb.	.09 1/4
Diacetone, tech., drums, l.c.l.	lb.	.10 1/2	Carbonate (potash) calc., wks, drums	lb.	.06 1/2
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.38	Cyanide, 94-96%, dom, dms., wks.	lb.	.55
Propyl-Iso, 99%, drums, l.c.l.	gal.	.43-.47	Pumice, ground, 1 1/2 F. & coarser, bbls., wks.	lb.	.03
Propyl-Normal, drums, wks.	gal.	.70	Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	\$172.
Alum, ammonia, granular, bbls., works	lb.	.035	Rochelle Salts, crystals, bbls.	lb.	36 1/4
Potash, granular, bbls., works	lb.	.0375	Rosin, gum, B, bbls., dock	lb.	.0211
Ammonia, aqua, 26°, carboys	lb.	.05 1/4	Silver, Chloride, dry, 50 oz. lots	oz.	37 1/2
Ammonium, chloride (sal-ammoniac), white, granu-	lb.	.0445	Cyanide, 100 oz. lots	oz.	33 1/4
lar, bbls., wks.	lb.	.0445	Nitrate, 100 oz. lots	oz.	26 1/2
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.65	Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0208
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40	Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Antimony Chloride (butter of antimony), sol.,	lb.	.17	Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
carboys	lb.	.17	Hyposulphite, crystals, bags, wks.	lb.	.0250
Barium Carbonate, ptd., bags, l.c.l., works	lb.	.025	Metasilicate, granular, 1-9 bbls.	lb.	.0335
Benzene (Benzol), 90%, drums, works	gal.	.19	Nitrate, rfd., gran., bbls., wks.	lb.	.029
Butyl Lactate, drums	lb.	.235	Phosphate, tribasic, tech., bbls., wks.	lb.	.0285
Cadmium Oxide, l.c.l., bbls.	lb.	.90	Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0560
Calcium Carbonate (Ppted, chalk), c.l., wks.	lb.	.02 1/4	Sesquisilicate, 1-9 drums	lb.	.0425
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05 1/4	Stannate, drums	lb.	.375
Carbon Tetrachloride, l.c.l., drums	gal.	.73	Sulphate, anhydrous, bbls., works	lb.	.0215
Chromic Sulphate, scale, 100 lb. drums	lb.	.45	Sulphocyanide, drums	lb.	28-47
Cobalt Sulphate, drums	lb.	.65	Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.0335
Copper, Acetate (verdigris), bbls.	lb.	22-24	Tin Chloride, crystals, kgs.	lb.	40 1/2
Carbonate, 52-54%, bbls.	lb.	.16 1/2	Toluene (Toluol), 2°, ind., drums, works	gal.	.32
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Trichlorethylene, drums, l.c.l., zone 1	lb.	.08 1/4
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535	Tripoli, air floated, bgs., c.l., wks.	ton	\$26.00
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.48 1/2	Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	38-40
Crocus Martis (iron oxide) red, bbls.	lb.	.03	Bees, yellow, crude, Brazil, 100 lbs.	lb.	.33
Dibutyl Phthalate, drums, l.c.l.	lb.	.195	Carnauba, refined, bags	lb.	.63-64
Diethylene Glycol, drums, l.c.l., works	lb.	.155	Montan, bags	lb.	No prices
Dextrin, white, bags, F.O.B. Chicago	lb.	.0375	Spermaceti, blocks	lb.	24-25
Emery (Turkish)	lb.	.07	Whiting, precipitated, bags, l.c.l.	ton	\$20.00
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.075	Xylene (Xylol), ind., returnable drums, works	gal.	.31
Ethylene Glycol, l.c.l., drums, works	lb.	.15 1/2-.18 1/2	Zinc, carbonate, tech., bbls.	lb.	14-16
Monoethyl ether, dms., l.c.l., wks.	lb.	.145	Cyanide, 100 lb. kegs	lb.	.33
Gold, Chloride, yellow, bottles	oz.	\$19.00	Chloride, tech., granular, drums, c.l., wks.	lb.	.05 1/4
Cyanide, potassium 41%, bottles, wks.	oz.	\$14.20-\$15.45	Sulphate, crystals, bbls., l.c.l.	lb.	.039
Gum, Arabic, white, powder, bbls.	lb.	.18-20			

MARCH, 1941

ORGANIC FINISHING

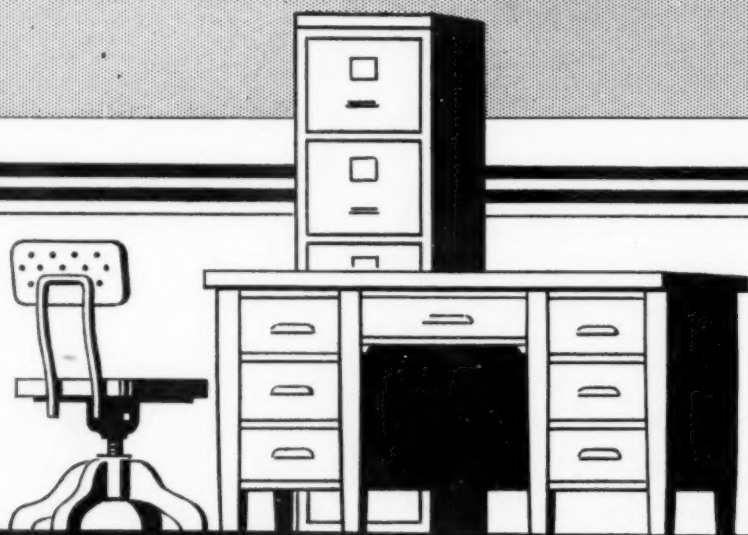
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SECTION OF METAL FINISHING

MARCH, 1941

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Picture on Cover
(Courtesy Eclipse Airbrush Co.,
Newark, N. J.)

Cleaning Previous to Organic Finishing

From observations of lacquered, enameled and painted articles on the market, it is evident that proper surface preparation is often not done, as evidenced by flaking, blistering and poor adhesion of the organic finish. Cleaning, and pickling of rust and scale, for highest adhesion of the organic finish, should be as thorough as is done for plating. This is not generally realized because organic deposits are not as hard and stiff and under such tension as plated coatings, and organic coatings, therefore, do not peel as noticeably. Yet the atomic forces holding organic finishes to metals are not greatly different from those causing adhesion between electroplate and base metal. The adhesion forces decrease exponentially with distance and when a coating is separated from the base metal at a distance greater than only 10 Angstrom units (0.00000004"), the adhesive force is sharply decreased.

The films causing poor adherence can be of either organic or inorganic nature. The organic dirt is usually oil of vegetable, mineral or animal types, and the inorganic dirt may be alkali, clay, lithopone, iron powder, rust, etc. Soap may also be responsible for poor adhesion as soap is difficultly rinsed and is frequently used in hot water drying to facilitate water shedding.

Oils may be left on the work from improper vapor degreasing where the cooling capacity of the work (light gauge material) may be insufficient to condense solvent in quantity to sufficiently rinse off all oil. Cold solvent cleaning, even using counter-flow technique, does not produce a chemically clean surface because when the solvent evaporates, it leaves a film of oil on the surface, as is evidenced by water-breaks if work so cleaned is rinsed in water.

A frequent cause of trouble is poor rinsing after alkali cleaning. Alkalies are difficult to completely rinse and acid dipping to neutralize them will facilitate rinsing.

Solid dirt may cause poor adhesion and this type of dirt may be removed with special spray solvent methods, electrocleaning, emulsifiable solvent cleaning or spray emulsion cleaning.

If rust proofing processes are employed, then light films may be removed, but for surfaces to be finished directly, one which will give no water-break and is smut-free, is desirable.

Proposed Reference Standards of Rusting of Painted Iron or Steel Surfaces*

A number of subcommittees of Committee D-1 on Paint, Varnish, Lacquer, and Related Products of the A.S.T.M. were confronted with the problem of accurately evaluating the degree of rusting exhibited by exposure panels. The preparation of reference standards of rusting in the form of colored photographs was, therefore, assigned as a portion of the work of Subcommittee VII on Accelerated Tests for Protective Coatings. In the meantime and pending the preparation of A.S.T.M. reference standards of rusting the various subcommittees of D-1 have been using the Swedish rusting standards. Consequently, a definite relationship exists between the Swedish rusting standards and these proposed reference standards.

It became at once evident that reference standards were necessary for two types of rusting failure. The first type would be used in the evaluation of subsurface rusting (blisters) which has progressed to some degree under the paint film with or without the presence of visible rust spots. The second type is not of the subsurface type and is visible as such.

The preparation of reference standards of rusting through the use of colored photographs involved the selection of rusty surfaces which photographically would represent their true condition.

In order to do this two precautions were necessary—the first was the selection of the proper color of paint

which would contrast sufficiently with the color of rust so that photographically it would avoid any error in interpretation. The second was to choose a surface which would not exhibit rust staining; otherwise rust staining might be confused with the presence of actual rust on the photograph.

Accordingly, a number of rusted surfaces were chosen and photographed. From these the proposed reference standards have been selected.

These problems involved in the preparation of reference standards of rusting were presented through the aid of colored projections to Committee D-1 in Atlantic City last June, together with proposals of specific tentative standards. It was then decided by Committee D-1 that black and white photographic representations of these proposed standards be published in the *A.S.T.M. Bulletin* so that all members of the Society and, particularly, the members of Committee D-1, be familiar with this proposal, and thus be in a position to approve or disapprove this as a tentative A.S.T.M. standard. This proposed tentative reference standard is as follows:

Proposed Tentative Reference Standards of Rusting of Painted Iron or Steel Surfaces

SCOPE

1. These proposed reference standards are representative of degrees of rusting of painted iron or steel sur-

faces for comparative purposes and are not intended to have a direct relationship to a decision regarding repainting requirements.

TYPES

2. Two types of rusting, as shown in Fig. 1, are represented:

Type 1.—Rusting, not accompanied by blistering and visible as such.

Type 2.—Rusting accompanied by blistering and which is not initially evident by visible rust.

USE OF REFERENCE STANDARDS

3. The use of these proposed reference standards requires the following precautions:

(1) Some finishes are stained by rust. This staining must not be confused with the actual rusting involved.

(2) Accumulated dirt or other material may make accurate determination of the degree of rusting difficult.

(3) Certain types of deposited dirt that contain iron or iron compounds may cause surface discoloration that should not be mistaken for corrosion.

(4) It must be realized that failure may vary over a given area and discretion must therefore be used in applying these proposed reference standards.

(5) In evaluating surfaces, consideration shall be given to the color of the finish coating, since failures will be more apparent on a finish that shows color contrast with rust, such as used in these proposed reference standards, than on a similar color, such as an iron oxide finish.

*From A.S.T.M. Bulletin, Dec., 1940.

Photographs Showing Proposed Tentative Reference Standards of Rusting of Painted Iron or Steel Surfaces

Type 1

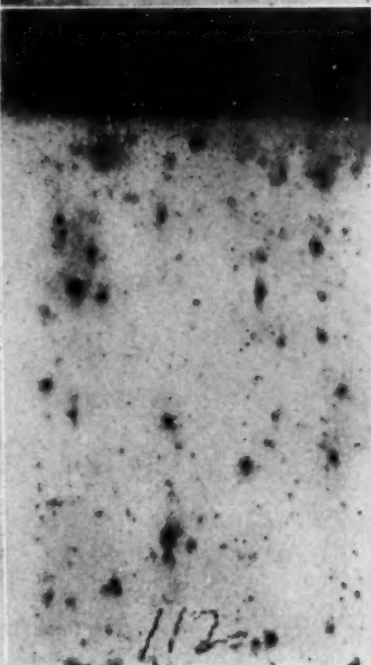
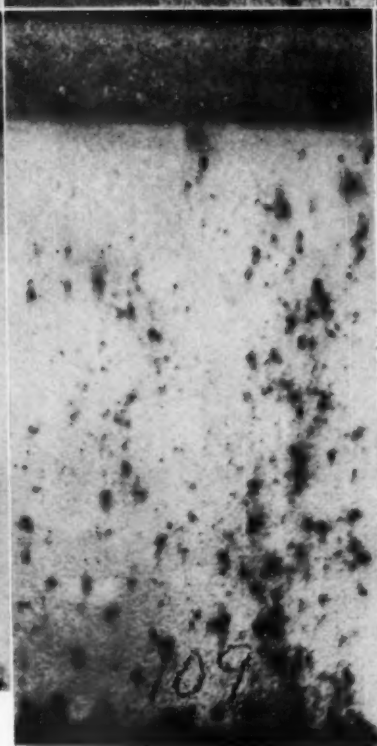
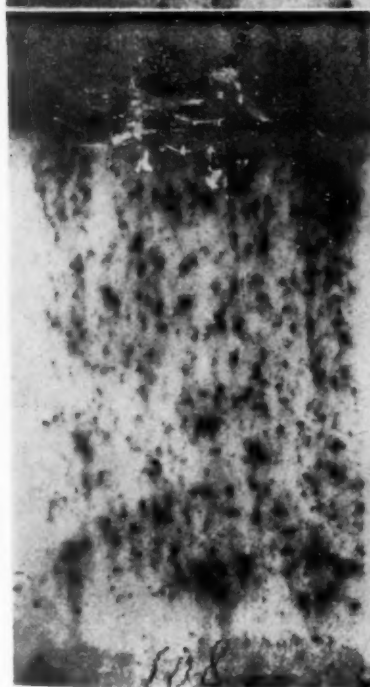
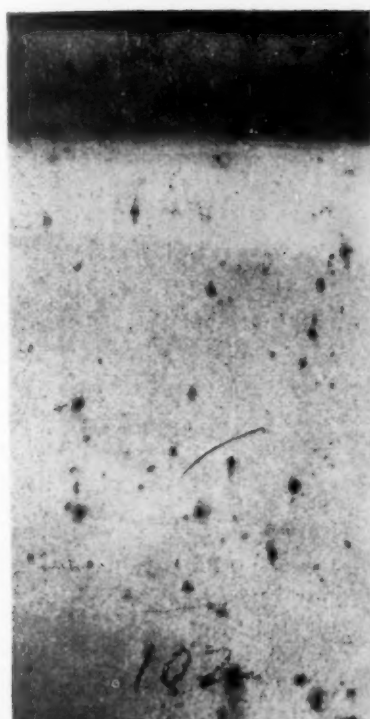
Rusting Not Accompanied by Blistering

Degree
of
Rusting

No. 8

No. 9

No. 10



Degree
of
Rusting

No. 44

No. 6

No. 7

Type 2

Rusting Accompanied by Blistering

Degree
of
Rusting

No. 7

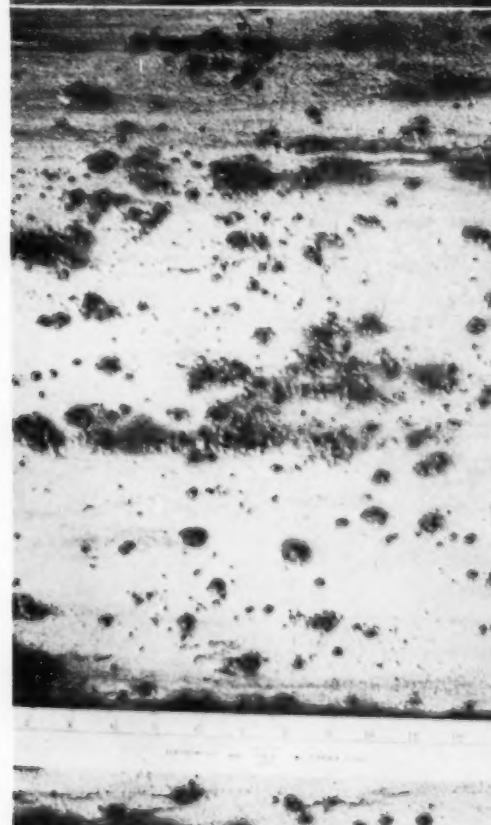


Degree
of
Rusting

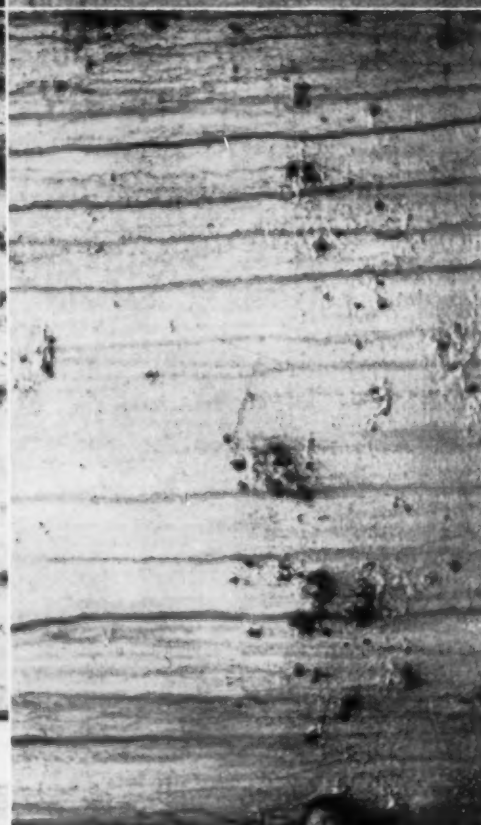
No. 8



No. 4†



No. 6



† Selections were made to agree within practical limits with the degree of rusting indicated for the corresponding reference standard numbers in the Swedish Rusting Standards. The subcommittee suggests that degrees below No. 4 are of no practical importance.

Analytical Determination of Paint Mileage

By FRED BUTLER

Zapon Brevolite Div.,
Atlas Powder Co., North Chicago, Ill.

Some time ago*, Willoughby G. Sheane, of the General Electric Co., Bridgeport, Conn., worked out a method of determining finishing cost calculations and this method has come into quite wide use since it was originally published.

We have found, however, that the method of determining film density may be improved, both as to time required to make the determination and also as to accuracy on repeat determinations.

The definition of density is the mass of the substance being measured contained in unit volume. In the metric system, the measurement of density is in grams per cubic centimeter. When any substance is immersed in water, it displaces its volume in the water, and loses in weight the weight of the volume of water displaced.

Therefore, the specific gravity, and thus the volume, may be determined by the following formula:

$$\text{Specific Gravity} = \frac{\text{Weight of a substance in air}}{\text{Loss of wt. of a substance in water}}$$

To get the pounds per gallon, multiply the specific gravity by 8.33, the weight of one gallon of water. The difference between the weight of water at various normal room temperatures is so slight as not to be a significant factor.

In the metric system (gram, centimeter, etc.) density and specific gravity are the same thing. Therefore, in determining the specific gravity of the paint-film we have its density. To do this, the weight of the paint-film in air, and its weight in water, to measure the weight of the volume of water displaced by the paint-film are needed. To do this the following procedure is recommended:

The author recommends an improved method for determining film density which is said to be more accurate and reproducible and can be done in a very short period of time. This new method is claimed to make the Sheane method of paint mileage more accurate.—Ed.

Accurate Determination of Paint Film Density

$$(1) \text{ Density} = \frac{F_a}{F_1} \text{ or } \frac{(\text{Weight of paint film in air})}{(\text{Loss of weight of paint film in water})}$$

$$(2) F_a = T_a - P_a$$

$$(3) F_1 = F_a - F_w$$

$$(4) F_w = T_w - P_w$$

Where (D) is the density of the dried paint-film (to be measured);

Where (F_a) is the actual weight of the paint-film in air;

Where (T_a) is the actual weight of the panel plus the paint-film;

Where (P_a) is the actual weight of the panel in air;

Where (F_w) is the actual weight of paint-film in water;

Where (T_w) is the actual weight of panel plus paint-film in water;

Where (P_w) is the actual weight of the panel in water;

Where (F_1) is the loss in weight of

the dried paint-film when immersed in water.

To be accurately determined, an analytical balance weighing to three or four places of a gram is needed.

- (1) For convenience a panel about 2 inches square is used, although the size of the panel makes no difference in the final results. This is weighed in the air and its weight recorded (P_a). The panel is then immersed in water and its weight also noted (P_w).
- (2) The panel is then dipped into the paint to be tested, and dried or baked according to the specified schedule as used in production.
- (3) The panel plus the dried paint-film is then weighed in air and its weight recorded (T_a), and then in water (T_w).
- (4) Subtract the weight of the panel in air (P_a) from the weight of the panel plus the dried paint in air (T_a) to determine the weight of the dried paint-film in air (F_a).
- (5) Subtract the weight of the panel in water (P_w) from weight of the panel plus the dried paint-film in water (T_w) to get the weight of the dried paint-film in water (F_w).
- (6) To determine the weight of the volume of water (F_1) displaced by the paint-film when immersed, subtract the weight of the paint-film in water (F_w) from the weight of the dried paint-film in air (F_a).
- (7) Substitute these values (F_a) and (F_1) in the formula for the determination of specific gravity, and thus density.

With the error reduced to such a small quantity, it now becomes possible to figure paint-mileage with any paint, lacquer, varnish, synthetic resin, etc. Thus the term "paint mileage" can be included as one of the tests in control



Fred Butler

*Metal Industry (Metal Finishing) 37, 77 (1939); 37, 122 (1939); 37, 328 (1939); 38, 239 (1940).

work as well as in sample analysis of vendor's paint. Henceforth it will have a definite determined value that can be accurately reached and maintained, instead of the rather ambiguous association that is commonly put to the term.

With this method, the operations needed are reduced to the following: The four weighings to determine the weight of the paint-film in air, and its weight in water; from which is calculated the loss of weight of the paint-film, the weight per gallon, and the actual dry solids of the paint (non-volatile). All of these can be determined within a period of 24 hours, and the actual weighing in two.

Completely reproducible figures on density which are possible by this method, make the Sheane method of mileage calculation considerably more accurate than it was previously.

Shop Problems

Small Particles on Work

Question. Will you please advise us as to what steps we might take to eliminate small particles which appear on our work. We know that some of this is due to dust and dirt in the air of our finishing room and, short of air conditioning which is not economically feasible, we have done everything possible to eliminate this factor such as periodically vacuum cleaning the room, wetting down the floor, etc. However, there are some days, particularly in the cold months when we have trouble, although it may only appear on one finish and not on the others. Your suggestions will be gratefully received.

Answer. If the proper thinner is being used and if your spray guns and lines are clean, your difficulty may very probably be due to a separation or throw out of tiny particles of the resins in your finishing materials. Your mention that you find some finishes dirty and others not in the cold weather points to this. It is suggested that you do not store your finishing materials in an unheated room or outside where they may be subjected to very low temperatures. It is also suggested that your materials be allowed to come to room temperature if they have been chilled before they are used.

Color Shades

Question. We have recently begun some work involving a number of colors. In this work there has been not a little confusion in the use of the various terms by which a color is described, particularly the terms tint and shade. We would greatly appreciate your referring us to some authoritative printed work on the subject of color in order that we may relieve our confusion.

Answer. In answer to your question on color we refer you to Report No. 38-10 prepared by E. I. du Pont de Nemours and Company, Inc. With regard to the terms tint and shade, the report states, when white is added

to a pure color in increasing quantities we form a series of *tints* ending in white after an overwhelming amount of white has been added. When black is added to a full color, or to a tint, we have a series of *shades* ending in black after an overwhelming amount of black has been added. Therefore, a *tint* is a tone of a color lightened by white and a *shade* is a tone darkened by black.

The report continues to describe the term *tone*. The term tone is exclusively applicable to the steps in a scale of a single color, comprising the full color as a center and graduated tints and shades leading from it in opposite directions.

+ +



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Aircraft Engine Finishes

Conclusion

DR. MYRON A. COLER

*Engineering Products Division
Paragon Paint & Varnish Corp.,
Long Island City, New York*

A GREAT variety of base materials are employed including bituminous japans, as well as the various oleoresinous and alkyd types mentioned in connection with crankcase finishes. Within the past year, rapid advances have been made in the improvement of baking finishes. A procedure described and highly recommended by an impartial source as late as 1939¹ calls for the use of a priming coat followed by a finishing coat of a different material; each coat must be baked for not less than two hours at temperatures not below 400°F. Finishes are now available which are self-priming, so that only one material need be used and all of the coats may be baked simultaneously; baking schedules requiring only fifteen minutes at 350°F or their equivalent are recommended².

The application problem in the case of cylinder enamels is far more acute than the corresponding problem for crankcases. An ordinary engine has just one crankcase but it may have fourteen cylinders. Because of their intricate shapes and deep-finned recesses, cylinders are usually spray coated and, therefore, cannot be properly finished unless they are quite free of the rest of the engine. If aircraft engines are to be turned out at production line speeds which are at all comparable with those of regular automotive work and if the field servicing units are to keep proper pace with the increased output, it is obvious that high speed finishes with good handling properties are essential.

Special Aircraft and Other Engines

While the above remarks have been made in reference to the finishing of regular aircraft engines, it is well to bear in mind the fact that all internal combustion engines have much in common; their exteriors are made of metals similar to or identical with

The first part of this article appeared in the February issue. In this concluding installment, U. S. Army and Naval Aeronautical Specifications for enamel finishing of aircraft engines are given.

those indicated in Table I, they become hot, lubricating oil may seep down their sides, gasoline may leak over their surfaces or be used to clean them, they may be employed in environments where the humidity is high and the air is laden with salt and abrasive dust. Differences in finishing requirements are usually differences in degree and emphasis. In marine work such properties as exceptional heat resistance and great stripping ease are usually not demanded but long life, availability in a variety of gay colors and ability to stand water and brine immersion are qualities which are particularly desired. For regular automotive work the present emphasis appears to be on quick-drying ability and low initial unit costs.

Motorcycle engines are in some respects even more exacting than aircraft engines in their ideal requirements. One manufacturer of motorcycle engines has estimated that temperatures "in spots reach as high as 650 to 700°F"; moreover, motorcycles move at only a fraction of the speed of regular aircraft so that the air-cooling may be less efficient even though the cylinders are almost totally exposed, and hence finishes having superior thermal characteristics may be needed. Unlike aircraft engines, no regular overhauls can be counted on so that long-term durability is important. Again, motorcycles are more exposed to all the elements, including sunshine and rain, so that good outdoor weathering properties are also desired. It is interesting to note that even though blimps may be equipped with regular airplane motors, their requirements closely parallel those for



motorcycles since their engines are usually well exposed and their cruising speeds low.

Cylinder Enamel Specifications

From the foregoing discussion, it may be seen that of all the finishing problems mentioned, the problem of providing suitable organic finishes for air-cooled high temperature aircraft engines is the most important. The problem of specifications from the standpoint of procurement operations has been recently reviewed by the author³; it was indicated in this review that the Government specifications covering aircraft cylinder enamels are representative in structure of specifications covering engine and aircraft finishes in general. Because of the importance of the cylinder finishing problem and because they are representative, it is worth mentioning two of the most dominant specifications: U. S. Army Specification No. 3-135¹⁷ and Navy Aeronautical Specification E-6e¹³.

U. S. Army Specification No. 3-135

This Specification refers by title to: "Enamel, Heat-Resistant, for Castings of Aluminum and Magnesium Alloys." Section VIII states in part: "The heat-resistant enamel is intended for finishing air-cooled cylinders, cast aluminum water jackets, or other cast aluminum or magnesium parts, especially when the parts are subjected to elevated temperatures . . . The use of this specification for the grade of material covered herein, is mandatory on all procuring agencies of the Army." It is essentially a restricted performance specification in that there are no composition requirements to be met, for

in accordance with section III, "the manufacturer is given wide latitude in the selection of materials and the process of manufacture so that an enamel of the highest quality may be produced." The detailed "Method of Inspection, Tests, etc." which represents the entirety of section VI is presented in Table II.

Navy Aeronautical Specification E-6e

This Specification refers by title to "Enamel, Black, Glyceryl Phthlate," and describes four types of enamel of which "Type I and II are intended for use as an exterior protective coating for metals, including aircraft engine cylinders" and "Type III and IV are intended for use as a protective coating for instruments." Types I and II are gloss blacks and Types III and IV are "instrument" blacks. Types I and III are air drying and II and IV are baking finishes. The complete "Detail Requirements", Section "E", are presented in Table III. Further details regarding tests may be found in the reference publication "Navy Aeronautical Specification for Inspection of Organic Protective Coatings for Aircraft."¹⁴ Although the E-6e Specification contains a number of performance and property clauses, it is essentially a *composition* specification.

Conclusion

From the foregoing sketch of modern field practice and typical specifications, it is obvious that the requirements of the existing specifications may not anticipate fully the needs of the aircraft industry. Thus, for example, in service work the stripping operation is an important part of the finishing cycle so that an ideal specification should provide for stripping tests or set up composition requirements that will assure proper ease of removal prior to refinishing. In attempting to set up more ideal specifications and to formulate finishes that will meet them, it is well to bear in mind the fact that the demands of the industry are in essence *performance* requirements and are on the whole, fair and legitimate since it is the industry which must be served. The demands of the industry which are not scientifically sound and are based on mere conventions or obsolete theories tend, of necessity, to disappear when more desirable materials and more efficient means of application are offered; a certain time lag must naturally be expected.

If a performance specification is properly drawn up, any composition of matter which satisfies its requirements should prove acceptable. A specification which overlooks any essential requirement fails of its purpose. A specification which makes demands that will never arise in practice usually creates unnecessary problems for the formulating chemists, useless and burdensome tests for the producing and receiving laboratories and

unwarranted expenditures on the part of the consumer. Again, provision must be made for developments in the aviation field; thus, for example, the finishing of Diesel aircraft engines² may involve problems not encountered in the finishing of gasoline engines or certain difficulties may even disappear so that less stringent and more economical specifications may be permissible.

It is interesting to note that the specifications introduced by the Ger-

TABLE II

U. S. ARMY SPECIFICATION No. 3-135 — VI. METHOD OF INSPECTION, TESTS, ETC.

1. The enamel shall be subject to *inspection* by authorized Government inspectors, who shall be given all necessary facilities to determine compliance with this specification.
2. *Acceptance* or approval of material in course of manufacture shall in no case be construed as a guaranty of the acceptance of the finished product.
3. *The tin panels* used in the following tests shall be cut from bright tin plate weighing not more than 25 grams and not less than 19 grams per square decimeter (0.51 to 0.39 pounds per square foot). (Commercial No. 31 gage bright tin plate should weigh about 0.44 pounds per square foot). It is important that the tin plate be within the limits specified. The panels shall be about 7.5 x 13 centimeters (3 x 5 inches) and shall be thoroughly cleaned with benzol immediately before use.
4. *Brushing and Covering Properties:* One coat of the enamel brushed on cast aluminum or magnesium shall completely hide the surface and dry in a vertical position without runs or sags.
5. *Drying Time.*
 - (a) Brush or flow the enamel on one of the tin panels described above and allow to dry. Place the panel in a nearly vertical position in a well-ventilated room, but not in the direct rays of the sun. The atmosphere of this room shall be free from products of combustion or laboratory fumes. The temperature of the room should be from 21 to 32 degrees Centigrade (70 to 90°F). The film is tested at points not less than 2.5 centimeters (1 inch) from the edges of the film by touching lightly with the finger. The enamel is considered to have set to touch when gentle pressure of the finger shows a tacky condition, but none of the paint adheres to the finger. The enamel is considered to have dried hard when the pressure that can be exerted between the thumb and finger does not move the film or leave a mark which remains noticeable after the spot is lightly polished. If rapid, light rubbing breaks the surface, the sample is considered not to have satisfactorily dried hard. In case the test shows time of setting to touch or drying hard to be more than 8 and 24 hours, respectively, two additional tests shall be run on different days, and if the enamel does not meet the above drying and hardening requirements on both of these additional tests it shall be considered unsatisfactory.
 - (b) *Umpire method of Analysis.*—In cases where different laboratories fail to agree on the drying test, due to different atmospheric conditions, and umpire tests are necessary, such tests shall be made in a well-ventilated room maintained at a temperature of 70°F. and relative humidity of 65 per cent saturation.
6. *Hot Water Resistance.*—Brush or flow the enamel on one of the tin panels described above and allow to dry for 48 hours under the conditions described in Section V, 5. Place this panel in a beaker containing 2½ inches of boiling distilled water (immersing the end of the panel which was uppermost during the drying period) and leave in water for 15 minutes. The enamel shall show only a slight dulling when observed after having dried for 2 hours at room temperature. Any marked dulling, fading, softening, checking, or other defect shall be considered cause for rejection.
7. *Gasoline Resistance.*—Brush or flow the enamel on one of the tin panels described above and allow to dry for 48 hours under the conditions described in Section VI, 5. Immerse the half of the panel which was uppermost during the drying test in gasoline conforming to Specification 2-40 for 24 hours. Any softening, blistering, checking, or other defects observed when the panel is allowed to dry for one hour after removing from the gasoline shall be considered cause for rejection.
8. *Baking Test.*—Brush or flow the enamel on a flat piece of cast aluminum or magnesium alloy, allow to dry for 24 hours, and bake at a temperature of 500 degrees Fahrenheit for a period of 24 hours. The finish shall not show signs of cracks or checks at the end of this period. In case the manufacturer recommends a special method of applying the enamel, these recommendations shall be followed in making the baking test.

TABLE III
NAVY AERONAUTICAL SPECIFICATION E-6e
DETAIL REQUIREMENTS

E-1. <i>Composition</i> .—Shall conform to the following, by weight:			
E-1a. <i>Product</i> :			
Non-volatile		Min.	33%
Volatile		Max.	67%
E-1b. <i>Non-volatile</i> :			
	Types I and II	Types III and IV	
Resin	Min. 90%	Min. 57%	
Pigments	Max. 10%	Max. 43%	
E-1c. <i>Volatile</i> :			
Hydrocarbon Solvents			100%
E-2. <i>Ingredients</i> .—Shall conform to the above and also to the following:			
E-2a. <i>Resin</i> .—Shall be a glyceryl phthalate type, showing not less than 31% phthalic anhydride quantitative, free from rosin and rosin derivatives.			
E-2b. <i>Drier</i> .—(Types I and III only.) Shall be as required to obtain the specified drying and baking properties with a high degree of package stability.			
E-2c. <i>Volatile</i> .—Shall have the following distillation characteristics:			
Initial Point		Min.	120° C (248° F)
50% Fraction		Min.	155° C (311° F)
End Point		Max.	213° C (415° F)
E-2d. <i>Pigments</i> .—Shall consist of carbon black (RM-131-1) and iron blue (RM-132-1) as required to match the standard shade, with the use of extenders of the silicate type only as required to obtain specified properties of gloss for types III and IV.			
E-3. <i>Appearance</i> .—Shall be uniform homogeneous and free from doubles. There shall be no trace of grit or rough particles.			
E-4. <i>Odor</i> .—Shall be normal for the volatiles permitted by the specification.			
E-5. <i>Coarse Particles</i> .—Shall not exceed 0.1 percent by weight retained on a No. 325 screen.			
E-6. <i>Viscosity (Package)</i> .—At 25° C (77° F) shall not be less than 1½ poises absolute for Types I and II, 1 poise absolute for types III and IV, not less than 24 hours after manufacture.			
E-7. <i>Weight per Gallon</i> .—At 25° C (77° F) shall not be less than 7.60 pounds.			
E-8. <i>Moisture Content</i> .—Shall not exceed 0.1 percent (Types I and II), 0.4 percent (Types III and IV) by weight.			
E-9. <i>Flash Point</i> .—Shall not be less than 27° C (80° F) for Types I and II.			
E-10. <i>Skinning</i> .—Shall be absent in a partly filled closed container after one week.			
E-11. <i>Application Properties</i> .			
E-11a. <i>Working Properties</i> .—When applied by brushing and spraying, it shall be a freely working product with acceptable leveling properties.			
E-11b. <i>Self-lifting Properties</i> (Types I and III).—Recoating after 7 and 18 hours shall produce no film irregularity.			
E-12. <i>Drying Properties</i> .			
E-12a. <i>Drying Time</i> .—A medium brush coat of types I and III shall air dry to touch in not more than 3 hours and dry firm and hard in not more than 18 hours. A medium brush coat of types II and IV shall dry firm and hard in not more than 15 minutes when baked at a temperature of 146 to 152° C (295 to 305° F), and when air dried it shall remain tacky at least 7 hours.			
E-12b. <i>Surface Appearance</i> .—The film upon drying shall be free from streaks, blisters, silking or other irregularities of surface.			
E-13. <i>Color and Gloss</i> .—When applied to a glass panel shall match the standard aircraft color cards.			
E-14. <i>Baking Properties</i> .—A flow-out film, air dried 18 hours (Types II and IV, a medium brush coat, air dried 15 minutes) and baked at 177 to 185° C (350 to 365° F) for 2 hours shall be hard, tough, smooth and free from all such defects as checking, wrinkling or dulling. The baked film shall show no appreciable discoloration.			
E-15. <i>Cold Cracking</i> .—The film on the baked panel above shall withstand a bend test of 180° around a 3/16 inch rod at 0° C (32° F).			
E-16. <i>Anchorage</i> .—The film on the baked panel above shall show satisfactory anchorage to the bent portion of the panel. It shall show a fine feathered edge on drawing a knife over the film.			
E-17. <i>Water Resistance (Hot)</i> .—A flow-out film, air dried 48 hours (Types II and IV), a medium brush coat, air dried 15 minutes, baked for 2 hours at 146 to 152° C (295 to 305° F), shall withstand immersion in boiling water for 10 minutes. It shall show no checking, blistering, appreciable whitening and only a very slight dulling when observed 5 minutes after removal, and no whitening 15 minutes after removal. The film on the immersed side shall be equal in hardness, toughness, gloss and anchorage to the film on the emersed side, 3 hours after removal.			
E-18. <i>Gasoline Resistance</i> .—A flow-out film, air dried 48 hours (Types II and IV), a medium brush coat, air dried 15 minutes, baked for 2 hours at 146 to 152° C (295 to 305° F), shall withstand immersion in gasoline for 4 hours; 24 hours after removal the film shall be equal in hardness, toughness, gloss and anchorage to the film of a similarly prepared panel which has not been subjected to gasoline.			
E-19. <i>Weather Resistance</i> .—The weather resistance shall be equal to and the discoloration shall be no greater than that of a standard control product when tested on a comparative basis. There shall be no premature checking or cracking failure.			

man War Office in 1936 in connection with the testing of paints for military equipment are essentially simple performance specifications¹⁵.

Acknowledgment

The author is grateful to I. Silberman, president of the Paragon Paint & Varnish Corporation, for his kindness in rendering the presentation of this material possible. Thanks are due to George F. McLaughlin, editor, and Michael H. Froelich, news editor, Aero Digest, and Professor Wm. Howlett Gardner of the Polytechnic Institute of Brooklyn, for their constructive criticisms and valuable suggestions.

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Loadings and Unloadings



Spraying



Baking and Cooling

NEAR INFRA RED DRYING EFFICIENCY INCREASED BY GIFFORD-WOOD CONVEYORS

The over-all efficiency of any Near Infra Red drying system depends on many factors. Important among them is the conveyor system. Gifford-Wood, with experience gained in designing many of the most important N-IR systems, offers special conveyors adapted to the

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One hand does the
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"We do 3 times the work with the Sterling SPEED-BLOC Sander than we could by hand-sanding. The work is far superior and we have cut costs substantially."

- Don't let surface preparation be a bottle neck in your production. With the new high-speed, air-driven Sterling Sander, you can sand, rub or polish flat or curved surfaces and produce better work in a fraction of the time. It not only helps you step up production schedules, but takes the high cost out of surface preparation by cutting labor and abrasive costs from 25 to 75%. Soon pays for itself.

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S-310 is a clear, pale liquid which can be reduced 150-200%. This solution can be applied to bright metal surfaces by dip or spray and gives a remarkably hard, tough and adhesive film of pronounced resistance to rust or tarnish.

S-310 is now used by many manufacturers of hand tools, e.g., hatchets, shears, pliers, axes, auto wrenches, etc.; for hardware of the better grade; for the bright metal surfaces of machine tools.

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Electric Sander Speeds Production

A Helpful Ally in Metal Fabricating Plant

Progress, speed, and efficiency are the order of the day, and manufacturers are finding that both time and money can be saved by the installation of modern equipment. At the Baldwin Brass Works, on Chicago's west side, established for more than eighty-five years, built-to-order products such as ornamental store fronts, elevator doors, wickets and grillwork for banks and offices, theater poster display cases, department store show cases, as well as a wide range of various styles of foot rails for bar fronts, with kick plates, push bars, ornaments, coat hangers, and chairs and tables to match, had been finished by laborious hand methods. This practice has now given way to the use of a special speed sander.

This sander is a standard unit in which the ratio of gearing has been altered to provide for a slower belt speed,—roughly, about 700 surface feet per minute. With this reduction

in speed, a more desirable finish is secured and the possibility of scratch marks appearing in the metal surfaces is reduced to a minimum.

The metals used in the various products fabricated at the Baldwin Brass Works are aluminum, bronze, brass, nickel, silver, and stainless steel, in a variety of shapes and sizes, some being as much as 14 ft. long by 4 ft. wide, in the form of flat sheets, tubing, rectangulars, tablets, and designs.

The old hand methods aided by the use of a large sanding machine driven by a 5-hp. motor was slow and costly, and the finish was not what might be desired in order to enhance the general appearance of the finished product. The change to the small electric sander has enabled the company to enjoy a savings of more than 50 per cent in labor time and 75 per cent in the cost of emery belting, since the

smaller belts cost much less than those used on the large machine.

The emery cloth belts used at the Baldwin plant range in grit from 40 to 220, the coarser grits being used on the tougher metals, working the surface down to a smooth satin finish. Extreme care is necessary, of course, when working on aluminum so as not to tear the metal. Work is finished with an emery-felt belt, after which the surfaces are washed thoroughly with a thinner and sprayed with a protective lacquer coating. All fabricated metal work is given a similar treatment, with the exception of stainless steel.

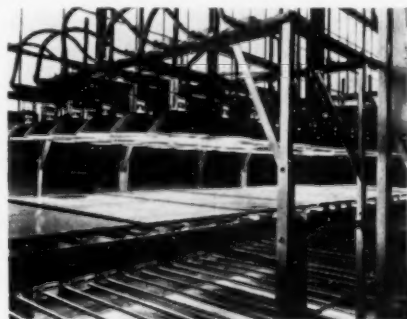
Anchor Post Fence Speeds Finishing With Infra-Red System

An interesting application of an infra-red finishing system is found at the Anchor Post Fence Company, Baltimore, where both completed oil burner units and large jacket panels are now baked out under lamps. Ault & Wiborg's finishing materials are used.

Anchor Post Fence manufactures the Fluid Heat oil burner, in addition to its line of steel fence sections. Jacket panels for the heaters are constructed of 20 gauge steel.



Sanding and Polishing Flat Metal Surfaces with Electric Sanding Machine.



No preheating is necessary. Full application of heat follows the instant the lamps are turned on. Cost of operating the oven is estimated at 20 cents an hour. The resultant finish on the oil burner panels and on the oil burners is reported to be tough, durable and uniform.

The operator in the spray booth applies a priming coat on the under side of the panel and a coat of Polymerin on the upper side. Over the Polymerin, a hammered-effect enamel, A & W's Polymeroid vehicle, is applied to give the desired "hammered-effect," and the panel is then ready for baking.

With infra-red drying lamps, illustrated here, this baking operation takes only eight minutes, the primer on the under side and the Polymeroid being baked simultaneously. The oil burners are finished with a Polymeroid finish in very much the same way. The baking cycle in this case is sixteen minutes. The equipment required occupies a space 30 feet long and five feet wide.

Patents

Modified Lacquer & Varnish Diluent

U. S. Patent No. 2,224,291 T. R. Donlan, assignor to Standard Oil Development Co., December 10, 1940. A coating composition comprising nitrocellulose, a solvent therefor, and a diluent containing a substantially pure petroleum hydrocarbon having a kauri butanol value over 50 and a boiling range of 90°-130°C., 6% of an acetate of the formula CH_3COOR (where R is an alkyl group) and up to 10% of an aliphatic alcohol.

Protection of Magnesium & Alloys

U. S. Patent No. 2,224,528 H. Sutton & L. R. LeBrocq (England), December 10, 1940. The protection of magnesium and high magnesium alloys from corrosion by immersion in a cold aqueous solution containing chromic acid ions and ions of an activator salt selected from the group consisting of aluminum salts and alum and in which the constituents of the solution and their relative proportions are selected so that the solution has a hydrogen ion concentration curve which remains for a considerable variation of acidity in the pH range which is required for producing a protective adherent film in the cold in a period not exceeding 2 hours, the solution being such that its pH value does not change more than 2 over part of said range for the addition of 12 g. of potassium hydroxide to 1 liter of the solution. For example:

Potassium dichromate	10 grams
Potassium alum	10 "
Potassium permanganate	5 "
Water	100 "
pH = 3.0 - 3.9	

Protection of Magnesium Alloys

U. S. Patent No. 2,224,245 F. A. Allen, assignor to High Duty Alloys, Ltd. (England), December 10, 1940. Production of a corrosion resisting film by immersion in an aqueous solution of alkali dichromate and metallic sulfate to which has been added an organic acidifying agent such as acetic acid and sodium acetate, maintaining such aqueous solution at a pH value between 2.0 and 6.4 at elevated temperatures.

Example:

Chromium sulfate	7.5 lbs. to 50 gal. (1.5%)
Potassium dichromate	15 lbs. " " (3.0%)
Acetic acid	2.5 pints " " (0.625%)
Sodium acetate	4 lbs. " " (0.8%)

Die castings are prepiped in 5% sulfuric acid and immersed for 20 minutes at pH 3.8 - 4.4 and at the boiling point. The finish is dark brown to black on drying. The patent also claims a preliminary treatment to remove grease and embedded dirt from stampings, sand castings and dirty articles, comprising immersion in a bath of 8% chromic acid and 5% nitric acid in water at room temperature for 10 minutes, followed by a quick sulfuric acid dip.

Acid & Alkali Resistant Paint

U. S. Patent No. 2,225,303 J. W. Iliff & W. F. Singleton, assignors to E. I. duPont de Nemours & Co., December 17, 1940. An acid and alkali resistant paint which has a metallic luster when dry, comprising 2 - 10 lbs. of finely divided leaded rubber and from 0.4 - 2 lbs. of chlorinated rubber for each gallon of coating composition.

Example:

Leaf lead paste	5.0 parts by weight
Chlorinated rubber	1.2 " " "
Plasticizer	0.6 " " "
Ester solvent	1.4 " " "
Hydrocarbon solvent	3.8 " " "

Coating Composition

U. S. Patent No. 2,225,664 A. Siegel, assignor to E. I. duPont de Nemours & Co., December 24, 1940. A durable coating composition comprising in combination a resin vehicle and a non-bleeding, vehicle-insoluble pigment ingredient comprising the manganous salt of the azo dye formed by coupling diazotized alpha-naphthalamine with 1-naphthol-5-sulfonic acid.

Tarnish Prevention

U. S. Patent No. 2,223,327 D. W. Light and L. P. Moore, assignors to American Cyanamid and Chemical Corp. Co., November 26, 1940. A method of preventing tarnish on silver and brass comprising coating with a lacquer containing a castor oil-modified phthalic glyceride resin and a butylated melamine-formaldehyde resin prepared by reacting from about 3 mols of formaldehyde to about 6 mols with 1 mol of melamine and with butanol under acid conditions and subjecting the coated metal to a temperature of about 150°C. until a hard clear coating is obtained.

Rust Remover

U. S. Patent No. 2,221,968 H. Friedmann, November 19, 1940. A stable viscous rust removing composition consisting of a mixture of phosphoric acid, of at least 1 low alkylated cellulose ether and of a fat dissolving substance.

Example: 1-2 grams of methyl cellulose is mixed at room temperature with 70 cc. of 26% phosphoric acid. An opaque jelly is produced, which may take 30 min. This jelly is the final product.

1940 BOUND VOLUMES Metal Finishing including

Organic Finishing Section

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WALKER'S Finishes to Fit the Product

Zinc Chromate Production Primers, Fillers, Surfacer & Undercoats, Short High Bake Enamels, Chlorinated Rubber Enamels, Rapid Drying Synthetic Enamels, Lacquers and Enamels for all Surfaces, Wrinkle Enamels and Novelty Finishes.

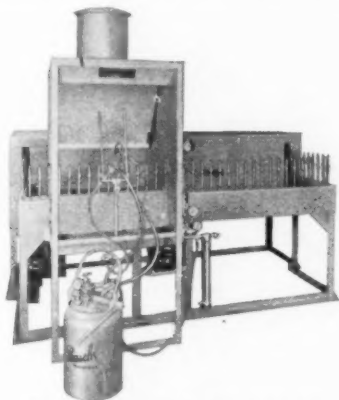
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MAKERS OF FINE FINISHES
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NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Shell Finishing Machine

This photo illustrates an automatic air-finishing and drying unit built by Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Ill., for application of black paint to 20 M.M. shells at a rate of 17,000 per 8-hour day. The unit includes special automatic air coating and drying unit approximately 8 ft. long by 3 ft. 9 in. wide, equipped with steel roller chain, supporting 164 revolving spindle assemblies, automatic off and on control for air brushes, varying speed pulley and reducer to operate the chain at speeds of 4 to 9 lineal ft. per minute, all mounted to structural steel frame, electrically welded.



Air coating and drying unit for finishing shells.

The unit includes one electrically welded drying oven approximately 8 ft. long by 1 ft. 8 in. wide by 1 ft. 6 in. high, insulated with rock wool and equipped with electric strip heater, thermostatically controlled to provide the required range in temperature. The unit also includes automatic air brushes, "Clamtight Cover" pressure feed material tank, water, oil and dirt separator to provide clean, dry air, including regulator and gauge, and exhaust unit with explosion-proof motor, spray booth and duct to fan.

Air Powered Mixers

Eastern Engineering Co., 45 Fox St., New Haven, Conn., have announced a new air powered mixer called "A-1" air mixer, which is recommended as a portable batch mixer



Air powered mixer.

for 50 or 100 gallon containers.

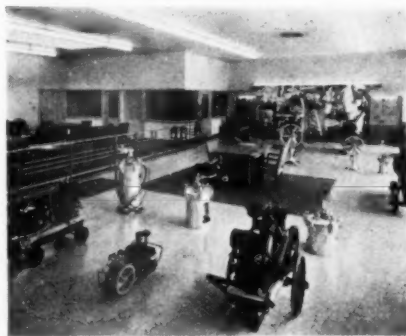
It is stated to be explosion proof and is completely enclosed, thus making it suitable for use in places where splashing of material or fumes may be harmful to the motor. The air motor is ball bearing, $\frac{1}{4}$ H.P. with a maximum speed of 2000 R.P.M. on 100 lbs. pressure. The speed can be varied by changing the air pressure. The shaft is made of stainless steel, coupled to the motor through a nickel plated tube type coupling. A 4" diameter nickel plated bronze propeller is fastened to the end of the shaft.

New DeVilbiss Service Branch

A new sales and service branch, modern in facilities, appointments and appearance, was opened recently in Chicago by the DeVilbiss Company, manufacturer of spray painting equipment, exhaust systems, air compressors and hose.

Located at 1280 West Washington Boulevard, an address convenient to the Chicago business district, branch is housed in a new building owned by DeVilbiss.

The building was designed and constructed to meet, adequately, the requirements of selling and servicing the company's equipment in the Chicago area.



View of new DeVilbiss service branch and showroom.

It features a spacious display room in which eye appeal plays no small part. This is of sufficient size to permit the display of the full line of industrial and service products made by the company.

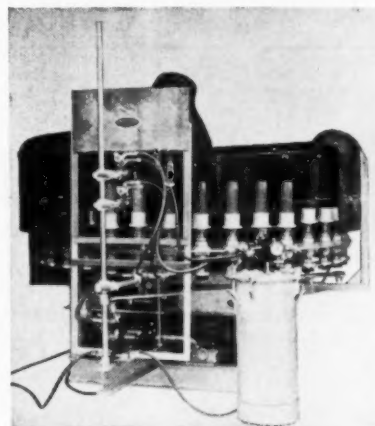
In one large department there are installed ready for operation, a number of the company's standardized automatic spray coating and spray finishing machines. Here a manufacturer can test modern, high speed, automatic spray coating as applied to his particular product and production conditions.

Complete, modern facilities for the servicing of equipment, a feature provided by the company in all of its branches, are also included in the new quarters.

Projectile Painting

The painting of projectiles from 37 mm. up to 155 mm. is handled automatically with a special machine developed by the Eclipse Air Brush Co., Inc., 400 Park Ave., Newark, N. J.

The machine pictured consists of a seven-foot indexed turntable with thirty-six rotating spindles carrying the shells in front of automatic spray guns that are synchronized with the turntable. After being spray-



Automatic machine for painting projectiles.

ed, the projectiles are carried through a steam jacketed, tunnel type, drying oven mounted on the table opposite the spray guns.

The shells are placed on the table, and removed, manually. The rate of operation is 500 an hour when six-minute pyroxylin lacquer is sprayed.

New Solvents Recovery Plant Open

The Solvents Recovery Service, Inc., with general offices and main plant at Newark, N. J., announce that their new plant at Linden, N. J., commenced operations on February 24th. This company is engaged exclusively in the business of recovering the solvents from dirty wash and lacquer thinners. It uses the Lofgren Process in recovering the solvents.

The new plant at Linden has been equipped with the latest type of recovery apparatus and will provide the Solvents Recovery Service with much needed facilities for handling the steadily increasing demand for this form of service.

Manufacturers' Literature Abrasion Tester

Taber Instrument Co., North Tonawanda, N. Y., in their bulletin No. 4012, describe their "Research Model" abraser which can be used for determining the abrasion resist-

and of organic finishes, anodized coatings, plated metals, leather, linoleum, upholstery and fabrics. The bulletin describes and illustrates various component parts and shows how to run an abrasion test, using the instrument. Abrasion tests on various surfaces and finishes are also illustrated.

Parkerizing

A 28-page booklet entitled, "Parkerizing is Rust-Proofing" has been recently issued by Parker Rust Proof Company, Detroit, Mich. Some new advances in the rust-proofing art described are: shortened processing time, lower operating temperature, smoother coatings, lower equipment and application costs. Typical procedure is outlined; namely, cleaning, processing and finishing.

Photographs illustrate typical equipment. Types of products suitable for Parkerizing are shown and listed. Photographs show the relative resistance of Parkerized and un-Parkerized surfaces to such corrosive

conditions as salt spray, tropical humidity and sea air.

The company's engineering and service staff, also jobbing plants are described.

New Spray Painting Catalog

Binks Manufacturing Company, 3114-40 Carroll Ave., Chicago, Ill., have just announced the publication of a new 92-page complete industrial catalog, covering all types of spray painting and finishing equipment.

This catalog is loose leaf in form and is handsomely bound in a red, laminated cellophane cover.

The catalog gives complete engineering data and specifications, together with prices on spray booths, spray guns, oil and water extractors, air supply and air exhaust systems, portable painting outfits and automatic finishing equipment, and all that pertains thereto.

A copy of this valuable catalog will be sent free of charge to anyone addressing the

sales promotion division of Binks Manufacturing Company on their letter heads.

Booklet on Cellulose Acetate

A new booklet on cellulose acetate has just been issued by Hercules Powder Company, Wilmington, Del., giving data on properties, application and formulation of the material in the plastics, lacquer, film, foil, paper, electrical, automobile and other fields.

The booklet contains tables on physical properties, film characteristics, solvents, resins, plasticizers, for use with cellulose acetate, and properties of lacquer films. Charts of viscosity concentration curves, of the water absorption of cellulose acetate plastics of varying acetylation, and a blending chart for different viscosities are given.

Data on melting point, density, refractive index, optical and electrical properties and water and chemical resistance are included. The booklet also covers the application, formulation and spraying of cellulose acetate lacquers. Plasticizers, formulation, thermal properties, color water resistance, finishing and production of cellulose acetate plastics are discussed.

Radiant Heat Drying Lamps

The Lamp Division of Westinghouse Electric & Mfg. Co., Bloomfield, N. J., have recently published a 12-page booklet describing and illustrating radiant heat drying, using their various type drying lamps. Data are given on relative radiant energy type of tungsten filament drying lamps and the various advantages of radiant heat drying are outlined. Typical installations of radiant heat drying lamps are shown. Technical information, valuable in evaluating radiant energy drying problems, is given.

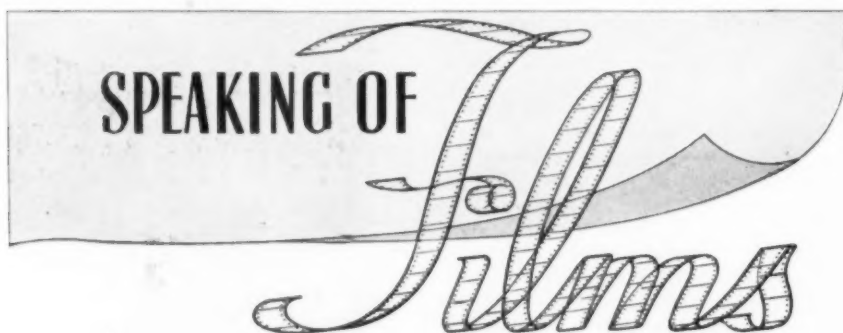
New Book

Review of Driers and Drying. By E. F. Bennett. 1941. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y. Size 8 1/2" x 5 1/2"; 84 pages. Price \$1.75.

This is a particularly complete compilation of the information on drying oils, the fundamental principles of the drying phenomenon, and the influence of metallic driers thereon, as worked out through many years by many investigators all over the world.

This book is a step towards a fuller understanding of the mechanism of the drying process and an addition to our knowledge of the subject. The work of the extremely capable investigators, through different methods of attack, have established the fundamentals of this complex phenomenon and their work is included in this book. Their work involved research in organic, inorganic, physical and colloid chemistry. The literature on this subject is scattered in a very large number of scientific journals, many of them of foreign origin, and not readily obtainable in all cases.

The 106 references cited in this review provide an illustration of the difficulty commonly experienced. This book, therefore, represents an attempt to collect and collate the existing work on the subject of driers and drying and to present a picture of the information published up to the present time as a whole.



In the Movies . . . it is the *better* films, like "Gone with the Wind" that attract the multitudes and create a box-office success.

And in Merchandising . . . it is the *better* "films" such as Egyptian produces that never fail to attract the multitudes and create selling successes.

Egyptian Lacquers and Egyptian Industrial Finishes are literally "films" of outstanding Beauty and durable Protection. They have proved their superiority on thousands of manufactured items during the past half century. So why experiment?

There is an Egyptian material for every finishing requirement . . . Lacquers and Synthetics in colors and clear . . . High Bake, Low Bake and Air Dry . . . Spray, Dip or Brush.

Write for information about our complete line . . . or better still, tell us your *complete* finishing problem and permit us to recommend the right finish.

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER NEW YORK



Research Model Abraser

Taber Instrument Co., North Tonawanda, N. Y., have announced the development of a new Research Model Abraser, which is said to be an efficient and accurate machine for testing and evaluating resistance of surface finishes to abrasion. The abramer is recommended for the testing of such substances as paints, lacquers, electroplated and plastic surfaces, and textile fabrics.

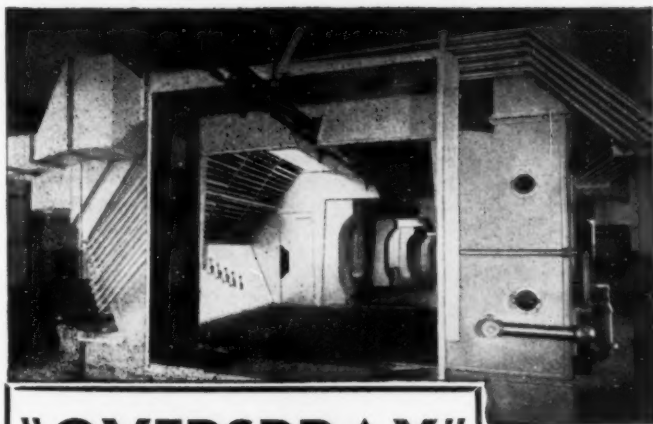
The primary elements of the abramer are the motor driven turntable on which the specimen is mounted, a counter to indicate the number of abrasion cycles, and two abrading wheels that alternately rub back and forth, and at the same time, criss-cross in their rolling path. These wheels are made in five types of closely controlled resilient material charged with special grades of fine abrasive grain.

The Research Model is provided with standardized load adjustment for varying the pressure of the wheels against the specimen to suit the type of material being tested. For instance, the pivoted arms, without auxiliary weights, apply a pressure against the specimen of 500 grams per wheel which is

recommended for general use on textile fabrics. The addition of the auxiliary weights increases the pressures to 100 grams which is the standard for longer wearing materials and finishes generally classified as paint, lacquer, plastics and metallic plating. In general the wheel pressure selected should accelerate the test to the point where the duration of the result ranges from 500 to 5000 abrasion cycles. Thin sensitive coatings and delicate fabrics require the use of the counterweight with which a pressure of 125 grams per wheel is obtained (arms less auxiliary weights). The lighter pressure increases the duration of the test permitting a better comparison than would otherwise be possible.

Supplementing the wear resistance test is the Shear-Hardness test performed by attachment E-3720 which measures the toughness quality of a plastic surface or its ability to resist digs, scrapes and similar physical damage not classed as normal wear.

The Eastern representative of this company is Alfred Suter, 200 Fifth Ave., New York, N. Y.



"OVERSPRAY" is eliminated in this INDUSTRIAL SPRAY BOOTH

If your production requirements
run up into volume - - - -

—whether your products are large or small you can step up efficiency through the use of this type of conveyORIZED spray booth system shown above.

Being of the "staggered", or "S" type, construction, this system offers no possibility of "overspray". Each booth in the group receives a supply of washed, filtered, and temperature-controlled air maintained at perfect balance between input and exhaust. This system can be operated at full efficiency with maximum or minimum production.

The hinged doors at the vestibule between each booth unit provide easy access from one booth to another without possibility of injury to operator.

Since this system has increased the efficiency in scores of plants, doesn't that suggest perhaps that a discussion with one of our engineers may prove profitable to you? Of course, there's no obligation.

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Physical Properties

Trichlorethylene is a clear, colorless liquid possessing the characteristically sweet odor of the chlorinated hydrocarbons. It has the molecular formula $\text{ClCH}:\text{CCl}_2$ and a molecular weight of 131.40.

The pure compound is listed as having a freezing point of -86.4°C . and a boiling point of 86.7°C . at 760 mm. mercury pressure. The specific gravity at $20^\circ/20^\circ\text{C}$. is 1.466 (approximately 12.2 pounds per gallon at 20°C .). The vapor pressure at 20°C . is 60.0 mm. mercury. Figure 1 shows the evaporation rate of trichlorethylene in comparison with ethyl acetate and other chlorinated hydrocarbons.

Trichlorethylene dissolves many waxes, fats, resins, oils, etc. and is miscible with most solvents. At 20°C . its solubility in water is only 0.10 per cent by weight. Water is soluble in it at 20°C . to a still lesser extent—0.02 per cent by weight. However, a constant boiling mixture of water and trichlorethylene is formed containing 7.0 per cent by weight of the former and boiling at 71.8°C . at 742 mm. mercury pressure.

Under normal conditions, trichlorethylene is stable in water if kept in the dark. On exposure to light its vapors in air tend to decompose with the elimination of HCl . Once free acid is present, decomposition may proceed quite rapidly. Metallic compounds and metal catalyze this reaction. This possibility must be guarded against, particularly when trichlorethylene which has been used for metal degreasing and which may contain metal chips and dust (particularly aluminum), is distilled. During the distillation, dichlorethylene may be formed when the HCl is set free and then spontaneously decomposes during the distillation.

When contaminated with certain oils, fats, etc. trichlorethylene may foam when boiled. Such foaming has been reduced by the addition of common salt, sodium chloride, in amounts of approximately one per cent.

Uses

Trichlorethylene possesses many valuable characteristics, chief among which is its high solvency for a wide variety of oils, greases, fats, waxes, tar, rubber, gums and resins. It is therefore largely used in the extraction of drugs, edible and unedible oils, in the purification of foodstuffs and explosives, in the recovery of grease and in analytical work. It is used in the dry cleaning of furs and many textile fabrics, in the degreasing of metals, leathers, raw wool, etc. and in the dewaxing of mineral oils.

In the chemical industries, trichlorethylene is used as a reagent and in the synthesis of intermediates, organic compounds and pharmaceuticals.

Other applications of trichlorethylene are as a refrigerant, as an insecticide, germicide and fumigant, as a constituent of glues and cements, paint removers, waterproofing compounds, cleaning and scouring compositions, etc. and for lowering the fire hazard of flammable solvents.

Physiological Properties

When inhaled for short periods of time, trichlorethylene causes a numbness in the head, vertigo, and smarting of the eyes. When breathed in higher concentrations, narcosis and disturbances of vision occur, in the latter case particularly where the vapors are warm.

Trichlorethylene has been used medically as an analgesic and is stated to be thirteen times more active than chloroform though less toxic. It has been recommended for treatment of certain types of neuralgia by inhalation. It has also been given internally and subcutaneously.

Because of its high solvency for oils and fats, trichlorethylene on contact with the skin removes the natural oils and irritations may result.

Specifications

The following are specifications of two grades of trichlorethylene which have been offered on the market.

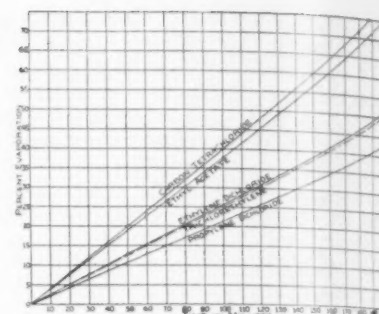
Specific Gravity	1.472-1.476 ($15/4^\circ\text{C}$.)	1.47-1.48 ($15/15^\circ\text{C}$.)
Color	25 Saybolt	water-white
Residue	none from filtered sample	none from filtered sample
Boiling Range	at least 95% shall boil between 86.0°C . and 87.5°C . at 760 mm. pressure	95% or better distills from 86.0°C . to 87.5°C . at 760 mm. pressure
Free Chlorine	none	none
Acidity	less than 0.003% as HCl	not more than 0.001% calculated as HCl
Water	no cloud at -10°C .	
Weight		12.33 pounds per gallon at 15°C .

Solubility of Various Natural Resins in Trichlorethylene

	25°C .	82°C .
Orange Shellac	I	I
Gum Accroides	SSD	SSD
Gum Mastie	SD	SD
Sandarac	TVGD	TVGD
Elemi	SD	SD
Pariette Gilsonite	PS	LS
Damar		
Batavia A/E	SD	SD
Singapore No. 2	SD	SD
Pale E. India Singapore Nubs	LSD	SD
Pale E. India Macassar Nubs	SD	SD
Black E. India Bold Scraped	TVGD	TVGD
Batu Bold Scraped	TVGD	TVGD
Copal Fossil		
Boea H. B. Amber	TVGD	GLD
Congo H. B. Amber Bold	TVGD	TVGD
Brown Kauri No. 3	TVGD	TVGD

S—90-100% dissolved
LS—50-90% dissolved
PS—25-50% dissolved
SS—5-25% dissolved

TVG—transparent viscous gel
GL—gelatinous liquid
D—darkens
I—insoluble



Comparative evaporation curves of chlorinated solvents.

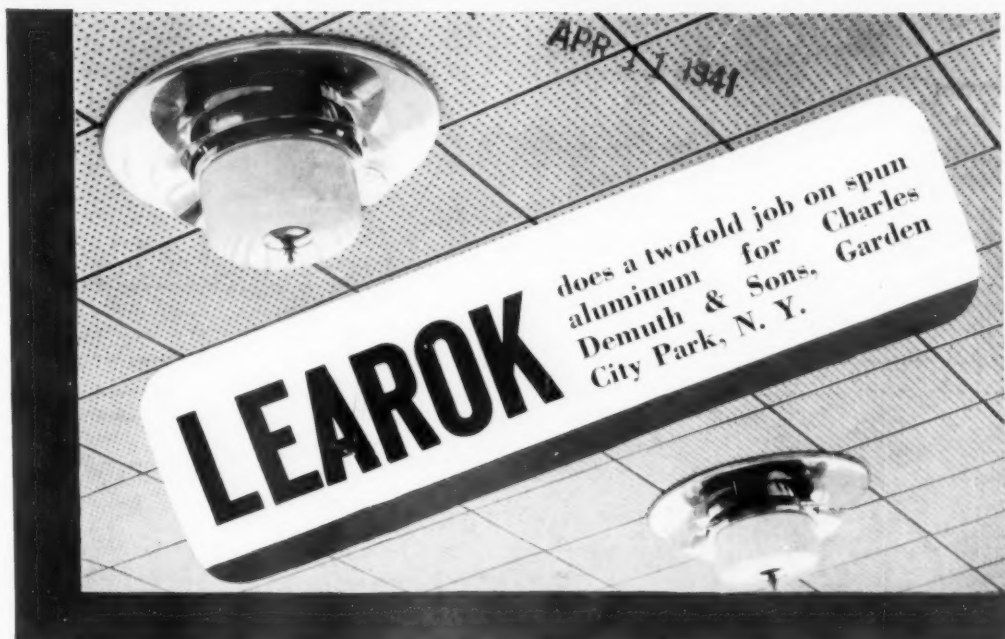
The relative toxicities of some of the chlorinated hydrocarbons, as obtained from various sources in medical and technical literature, is as follows: Carbon tetrachloride is arbitrarily taken as having a value of 1.0.

Tetrachlormethane (carbon tetrachloride)	1.0
Perchlorethylene	1.6
Trichlorethylene	1.7
Dichlorethylene	1.7
Trichloromethane (chloroform)	2.2
Pentachlorethane	6.2
Tetrachlorethane	9.1

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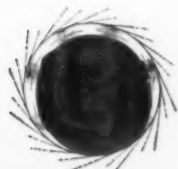


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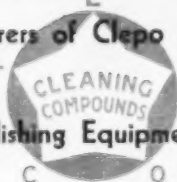
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Founded as METAL INDUSTRY,
January, 1903 by
PALMER H. LANGDON
1868-1935

VOLUME 39

APRIL, 1941

NUMBER 4

Publication Office:
116 John Street, New York



L. H. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1941
by The Metal Industry Publishing Company,
Incorporated, 116 John St., New York,
N. Y. Entered February 25, 1903, at New
York, N. Y., as second class matter under
Act of Congress, March 3, 1879. Re-
entered as second class matter June 13,
1940, at the post office at New York,
N. Y., under the Act of March 3, 1879.

SUBSCRIPTION PRICES: United States,
\$2.00 per year; Canada, \$2.50 per year
(includes 50c exchange and tax). Foreign
\$5.00. Single copies 25c. Please remit by
check or money order; cash should be
registered.

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Nickel Plating with Insoluble Anodes

The current shortage of nickel for plating purposes is causing much concern, and in view of the indefiniteness of the situation, substitutes for nickel are being sought and new problems have arisen. Obviously, the first thing to do is to increase the thickness of the undercoat of copper and use less nickel for the cases where copper-nickel-chromium coatings are used. This is already being done. Another expedient is to use bright nickel plate over buffed finishes and eliminate the buffing of the nickel. It is estimated that from 5 to 20% of the nickel is lost in the buffing of dull deposits such as are obtained from the Watts bath. The use of reclaim rinses as mentioned in a previous editorial should also be adopted, and analytical control of the solution should be regularly done to avoid unnecessary loss from drag-out of too highly concentrated solutions.

Cases have arisen and will continue to arise where nickel salts may be available to the plater and not anodes. This raises the question whether plating can be done from insoluble anodes. When inert anodes such as carbon are used, several things occur which are not experienced when nickel anodes are used. First, the solution will naturally deplete rapidly in nickel; secondly, the pH of the solution will change much more rapidly with inert anodes because oxygen will be discharged at the anode, which in effect, is removal of hydroxyl ions thus causing the solution to become acid. Chlorine may also be evolved at the anode.

The net effect then of operating without nickel anodes will be to change the nickel sulfate into sulphuric acid. As long as oxygen is discharging at the anode faster than hydrogen at the cathode, this will inexorably happen. The effects of chlorine are not so serious as chlorides are not necessary when nickel anodes are not used and when the chlorides have been used up, no more need be added until nickel anodes are used again.

The pH change of the solution can be retarded considerably by the use of proper buffers. Proper buffering of nickel solutions, and in fact most plating solutions, has been seriously neglected. The

principal attempts at buffering in the past have been with boric acid, a so-called buffer. Actually, boric acid has little or no buffering action at pH's below 5 and very little between pH's 5 and 6.5. Although boric acid is a poor buffer for nickel solutions in the usual concept of buffering, it has a purpose in that its slight buffering action probably is effective in the region of the cathode film which is more alkaline than the body of the solution and thus boric acid may have a valuable function even in low pH nickel plating solutions. This does not mean, however, that real buffers would not be of value to plating solutions.

We predict that when satisfactory buffering of plating solutions of the acid type has been accomplished, much higher current densities will be able to be used than those used at present. The principal cause for burning and poor plate, at the high current density limits for nickel plating, is the co-precipitation of basic nickel compounds and not hydrogen. The discharge of hydrogen indirectly causes the burning by leaving the film more alkaline, but hydrogen is not the direct cause for burning. Any factors which will mitigate against the discharge of hydrogen and prevent the discharge of basic salts will enable higher current densities to be used.

Organic acids and their salts are good buffers and among these are the following: acetic acid and sodium acetate; formic acid and sodium formate; citric acid and sodium citrate; hydrofluoric acid and sodium fluoride and many other organic acids and their salts. Unfortunately, most of the buffers mentioned have a buffering range below pH of 5, and therefore their use may cause a slight reduction in throwing power, but bright nickel solutions are being operated satisfactorily within the buffering pH ranges of the above-mentioned buffers.

It is possible that some of the buffer combinations mentioned above or other true buffers will be satisfactory to use in nickel plating both when nickel anodes are and are not used. The effects of these buffers on other properties of the bath will have to be first determined and it is hoped that this work will not be long in being done.

Adhesion of Nickel Deposits*

BY E. J. ROEHL

Research Laboratory,
International Nickel Co.,
Bayonne, N. J.

OF the various tests which have been devised to determine quantitatively the degree of adhesion of electrodeposits to the base metals, the method due to Ollard¹ and applied by Hothersall² is the most satisfactory. The present paper describes a refinement of Ollard's test by more closely defining the dimensions of the test piece so that when the deposit and base metal are separated, the break occurs more nearly by tensile separation. By means of Ollard's method, a study has been made of various base metal cleaning treatments, in order to evaluate their efficiency and to provide treatments which will ensure high adhesion of nickel deposits, both hard and soft, to a number of base metals. The base metals studied were: high and low-carbon steels, cast and wrought iron, composite nickel and steel surfaces, nickel itself, copper, Ni-Mo steel and Ni-Mo cast iron.

The problem of the adhesion of deposit to the base metal is one of primary importance in all types of plating, but in the field of heavy nickel deposits for the building up of worn or mismachined parts and for the protection of parts against combined wear and corrosion, good adhesion is a first requisite. The deposits are often ground or machined to size, or may be used as bearing surfaces, and thus subjected to high stress. Since these parts rarely have as their primary object the production of an attractively appearing surface, cleaning methods may be employed which would be out of the question for decorative work. The hardness of nickel electrodeposits can be varied, depending upon the plating conditions, from 160 to 500 Vickers, and thus provide a wide scope for various engineering purposes.

The Ollard Test

Fig. 1 shows the various steps in the Ollard test method. A machined test piece 1.00-in. in diameter by 1.50-in. long is fitted with a connecting wire; the whole specimen is stopped off with Halowax and the wax then removed from a portion of the surface as indicated in A. The piece is cleaned by the method it is desired to study and an electrodeposit approximately 0.10" thick formed on the exposed end. The wax is then removed and the piece machined to give a total length of 1.51" from the unplated end to the under side of the nickel deposit; that is, 0.01" of nickel is machined off so that no nickel will remain on the cylindrical surface of the test piece itself and the interface between nickel and base metal will be well below the shoulder of the finished specimen. At the same time a hole $\frac{3}{4}$ " in diameter by about $\frac{3}{8}$ " in depth is drilled through the nickel and base metal, as indicated in B. The test piece is then supported in the die C and a load applied by means of a

The Ollard adhesion test is used to evaluate the efficiency of various etching methods in the preparation of several base metals prior to nickel plating. Also a study of the Ollard test procedure has shown that by a suitable choice of exact dimensions in the test piece and apparatus, adhesion values can be obtained which represent a closer approach to tensile separation of deposit and base metal than that obtained in the original Ollard test, both from practical and theoretical viewpoints.

Satisfactory etching methods for preparing the following base metals are demonstrated herein: high and low-carbon steels, cast iron, wrought iron, composite surfaces of nickel and steel and nickel itself. Satisfactory etching methods also are given for Ni-Mo steel and Ni-Mo cast iron.

With a steel base, adhesion greater than the tensile strength of the electrodeposit was observed, and with cast iron, the break takes place in the base metal. Perfect adhesion of nickel on nickel is exemplified by continuation of the base metal structure in the deposit itself.

rod in a tensile machine. D indicates the appearance of the test piece after the nickel ring has been forced off. From the value of the load and the area of contact between deposits and base metal, the adhesion in terms of lb. per sq. in. can be calculated.

Fig. 2 is a cross-section of a test specimen just prior to breaking in the tensile machine.

Study of Adhesion

The most important factor in obtaining good adhesion is adequate cleaning and preparation of the surface of the



Fig. 1. Various steps in the Ollard test method. About $\frac{3}{4}$ actual size.

† Reprinted from *The Iron Age*, Sept. 26 and Oct. 3 (1940).

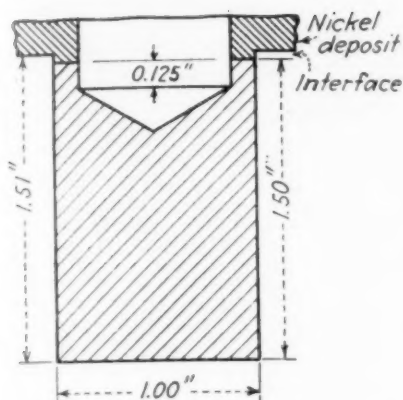


Fig. 2. Cross-section of Ollard test specimen.

base metal. The surface must be chemically clean and for maximum adhesion, where the values are of the same order of magnitude as the tensile strength of the base metal, the weak distorted surface layer formed in polishing must be removed by etching.

In order to study the efficiency of various cleaning procedures, a number of samples of steel, cast and wrought iron were prepared and tested for adhesion by Ollard's method. The procedures shown in Tables I, II and III were followed.

The first action of the anodic etch probably is to remove the polished layer and expose the base crystal structure, after which the work goes passive and gasses. During the first stage of the treatment, the anode efficiency of the dissolving iron is quite low as can be seen in Fig. 3, taken from the work of Salauze⁴, where the anode current density is plotted against the anode efficiency for iron in H_2SO_4 solutions of varying concentrations. (25 per cent H_2SO_4 by weight is equivalent to 22° Be.) Some gassing will thus occur during this period, and a black film is left on the surface. It is necessary to remove this film (it probably was not removed in method 5 in Table II) in order to secure good adhesion and this is accomplished during the second stage of the treatment when vigorous gassing occurs—at a point during this stage the film is lifted, almost in one piece, leaving a bright surface in the case of mild steel and a generally rather darker one for high carbon steel.

The cleaning treatment in all of the following cases consisted, after the same preliminary procedure as employed for steel, of an anodic etch in 25 per cent H_2SO_4 (by weight) at room temperature. Results are given in Tables II and III.

Fig. 7 shows the specimen obtained under treatment No. 2, Table III. It can be seen that the break occurred entirely in the cast iron. Fig. 8 shows the extent to which etching of the base metal occurred under treatment No. 5.

INVESTIGATION of the Ollard test: In Ollard's work no definite dimensions were given as to the diameter of the central hole drilled in the test piece; he used a hole $\frac{3}{4}$ " in diameter and indicated that increasing this diameter gave higher results. Hothersall^{2,5}, also used a $\frac{3}{4}$ " hole in his work, but neither author gives a specific figure for the hole diameter of the die. If the test piece fits too tightly in the die, there is danger of binding, and if the fit is too loose, concentration of stress at the outer edge of the junction of

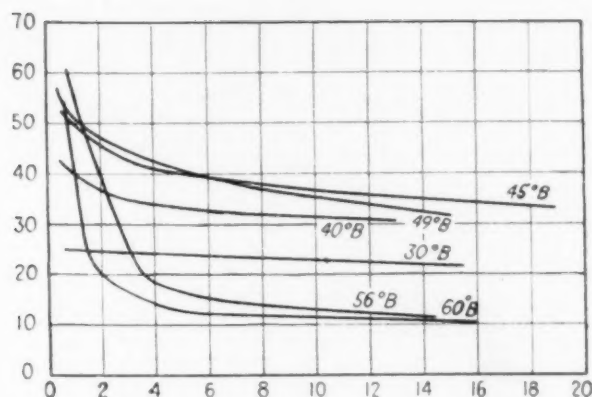


Fig. 3. Corrosion of iron anode in H_2SO_4 solutions.



Fig. 4. Cast iron with well distributed carbon, in direction parallel to deposit. Unetched. At 100 diameters.

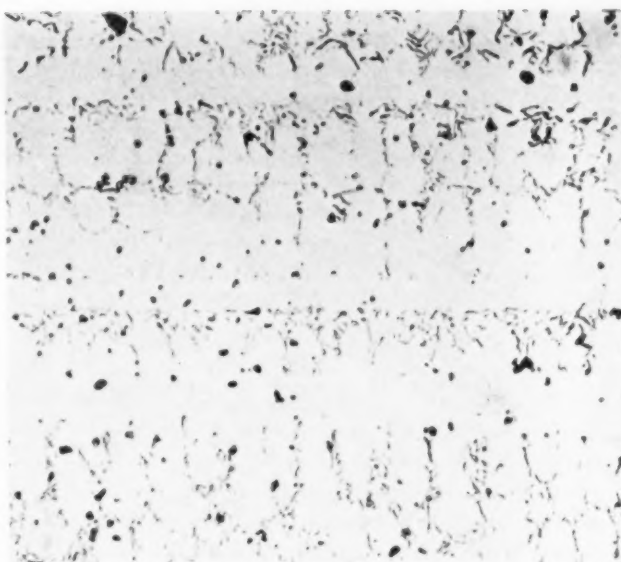


Fig. 5. Cast iron with poorly distributed carbon, in direction parallel to deposit. Unetched. At 100 diameters.

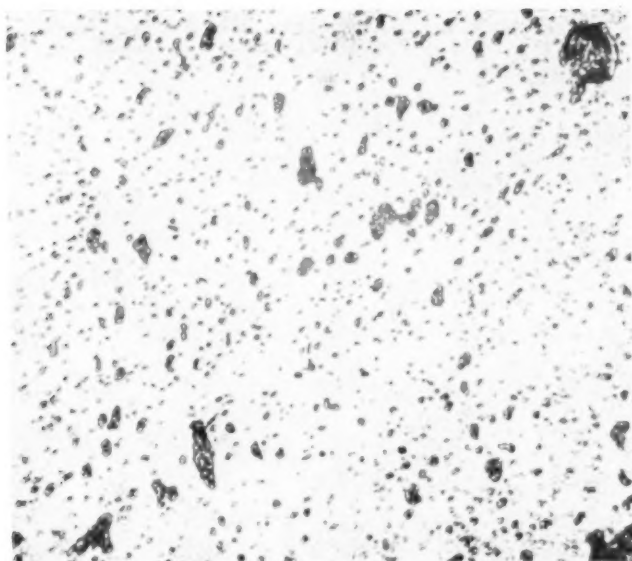


Fig. 6. Wrought iron in direction parallel to deposit. Unetched. At 100 diameters.

deposit and base metal will result in a low value for the adhesion.

Hothersall reported an adhesion value of 56,200 lb. per sq. in. for nickel deposited on mild steel, a value considerably higher than the results obtained in the present work up to this point, and it was felt that the discrepancy probably lay in the testing method rather than in the cleaning operation. In the data given in Tables II and III, the relative values of the adhesion figures are precise, it is their absolute values which are in question. In order to study the dimensional variables, tests were run using method No. 4 (4 min.) of Table II on a heat treated steel which had a tensile strength of about 120,000 lb. per sq. in. The data are given in Tables IV, V and VI.

Decreasing the diameter of the die hole and increasing the hole diameter of the test piece led to marked increases in the adhesion values. There seems to be little choice between the two smaller dies, and as there was a tendency for binding to occur in the 1.010-in. die, the 1.020-in. die was used in the further work.

Up to a deposit thickness of 0.098", the adhesion values increased rapidly, but the deposit was too thin and tended to fold up into a cup shape. Above this thickness value there was no folding and the overhanging rim of the deposit was sheared off. At the higher thicknesses, the values increase slightly, probably due to the greater resistance to shear offered by the increase in thickness. Fig. 9 shows such a sheared deposit.

There are three possible modes in which the deposit may be separated from the base metal in the Ollard test:

(1) *By bending.* This is probably the manner in which separation occurs in the original Ollard test, and under which conditions the data in Tables II and III were obtained.

(2) *By shearing.* This is illustrated by the data for higher thickness in Table V and by Fig. 9.

(3) *By tensile separation,* whether at the interface, in the base metal or in the deposit. This is the only condition under which the test will be valid.

Data are not available for electrodeposited nickel, but for hot rolled nickel, the ratio of tensile to shear strength is

TABLE I
Procedure Followed to Prepare Specimens for Adhesion Test

Plating Bath:		
NiSO ₄ . 7 H ₂ O	330 gm. per liter	
NiCl ₂ . 6 H ₂ O	30 " " "	
H ₂ BO ₃	30 " " "	
Temp. 130 deg. F.; pH 2.0 (electro-metric), C.D.	50 amp. per sq. ft.	
Deposit hardness	160 Vickers	

Test Piece Dimensions:	
Deposit thickness	0.070 to 0.10 in.
1.030 in. hole diameter in die	
Duplicate runs in all cases	

Preliminary Cleaning Treatment:	
Pumice scrub and cold water rinse.	
Cathodic alkaline treatment for 2 min. at 100 amp. per sq. ft., 140° F., solution composed of 8 gm. per liter NaOH, 1.06 gm. per liter Na ₂ CO ₃ .	
Pumice scrub and cold water rinse.	
Cathodic alkaline treatment for ½ min.	
Cold water rinse.	

This procedure was then followed by the various etching treatments indicated in Table II, then by a cold water rinse, after which they were placed in the plating bath with the electrical connections made.

TABLE II
Etching Treatments and Adhesion Values, Using the Original Ollard Test. Base Metal, Steel.

Etching Treatment	Test Values	
	Ollard Drill Rod (0.97 C.)	Mild Steel (0.20 C.)
(1) Simple immersion in 15 per cent HCl (by weight) 140° F., 2 min.	6,300	5,200
(2) Anodic, 25 per cent H ₂ SO ₄ (by weight), 20 amp. per sq. ft., room temperature, 10 min. Increase current density to 200 amp. per sq. ft. for 2 min. Cathodic for 2 to 3 sec.	16,000	22,500
(3) Anodic, 25 per cent H ₂ SO ₄ (by weight), 200 amp. per sq. ft., room temperature, 2 min. Cathodic for 2 to 3 sec.	7,500	
(4) Anodic, 25 per cent H ₂ SO ₄ (by weight), 200 amp. per sq. ft., room temperature,		
1 min.	12,200	
2 min.	16,000	13,000
3 min.	18,000	15,500
4 min.		18,000
(5) Anodic, 67 per cent H ₂ SO ₄ (by weight), 100 amp. per sq. ft., room temperature, 20 sec.	No adhesion	
(6) Method of McLare. ³ Anodic, 25 per cent H ₂ SO ₄ (by weight), 100 amp. per sq. ft., room temperature, for 20 sec., after oxygen is first evolved	18,000	8,500

about 1.3, which means that in order to obtain the third type of separation, the cylindrical area subject to shear should be at least 1.3 times the annular area subject to tension. The area in shear = $\pi d h$ where d is the diameter

TABLE III
Etching Treatments and Adhesion Values, Using the Original Ollard Test. Cast and Wrought Iron.

Base Metal	Etching Treatment	Ollard Test Values, Lb. Per Sq. In.
Cast iron with well-distributed carbon (Fig. 4)	(1) 100 amp. per sq. ft. Removed as soon as gassing started (1½ min.)	985
	(2) 100 amp. per sq. ft. Allowed to gas for 1 min.	20,000
	(3) 100 amp. per sq. ft. Total time 5 min. —gassed for 1½ min.	20,000
	(4) 200 amp. per sq. ft., 4 min.	4,160
	(5) 200 amp. per sq. ft., 6 min.	16,900
	(6) 400 amp. per sq. ft., 4 min.	13,000
	(7) 400 amp. per sq. ft., 6 min.	12,500
Cast iron with poorly distributed carbon (Fig. 5)	(8) 100 amp. per sq. ft., 5 min.	15,000
Wrought iron with slag inclusions (Fig. 6)	(9) 100 amp. per sq. ft., 5 min.	13,800

TABLE IV
Ollard Adhesion Values on Steel. Variation in Die Hole Diameter. (Deposit Thickness Greater Than 0.08 In.)

Hole Diameter of Test Piece, In.	Hole Diameter of Die		
	1.010"	1.020"	1.030"
0.750	37,500	33,600	14,500 lb. per sq. in.
0.813	46,000	46,300	—
0.875	73,000	51,200	—
0.938	77,000	74,500	22,000 lb. per sq. in.

TABLE V
Ollard Adhesion Values on Steel. Variation in Deposit Thickness.

Hole Diameter of Test Piece, In.	Hole Diameter of Die, In.	Deposit Thickness, In.	Ollard Test Values, Lb. Per Sq. In.	Ratio of Shear to Tension Area
0.75	1.020	0.065	20,200	0.49
0.75	1.020	0.084	27,500	0.67
0.75	1.020	0.098	34,500	0.79
0.75	1.020	0.118	35,500	0.98
0.75	1.020	0.128	36,500	1.07

TABLE VI
Ollard Adhesion Values on Steel. Variation in Deposit Thickness.

Hole Diameter of Test Piece, In.	Hole Diameter of Die, In.	Deposit Thickness, In.	Ollard Test Values, Lb. Per Sq. In.	Ratio of Shear to Tension Area
0.938	1.020	0.070	69,000	1.98
0.938	1.020	0.087	85,000	2.54
0.938	1.020	0.100	85,000	2.97
0.938	1.020	0.121	85,000	3.66

TABLE VII
Tensile and Ollard Tests on Nickel and Steel.

Material	Tensile Test	Ollard Test
Nickel	79,000	78,200
Nickel	79,000	79,800
Steel	128,000	141,200
Steel	128,500	141,700

TABLE VIII
Adhesion Values, Modified Ollard Test

Base Metal	Cleaning Treatment	Lb. Per Sq. In.
Steel (120,000 lb. per sq. in. tensile strength)	Table II, method No. 4 (4 min.)	94,500
		91,700
Cast iron	Table III, method No. 3	Breaks in steel
		24,400
Cast iron	Table III, method No. 3, then 0.0002" deposit from copper cyanide plating bath; cold water rinse, 30-sec. dip in 10 per cent HCl (by weight) at room temperature, cold water rinse.	26,900
		Breaks in cast iron
Cast iron	Table III, method No. 3, and copper deposit. Cold water rinse. Anodic, ammonium citrate solution, 10 amp. per sq. ft., room temperature, 60 sec. (Hothersall. ⁶)	6,850
		7,350
Cast iron	Table III, method No. 3, and copper deposit. Cold water rinse. Anodic, ammonium citrate solution, 10 amp. per sq. ft., room temperature, 60 sec. (Hothersall. ⁶)	Break in copper layer
		7,150
Cast iron	Table III, method No. 3, and copper deposit. Cold water rinse. Anodic, ammonium citrate solution, 10 amp. per sq. ft., room temperature, 60 sec. (Hothersall. ⁶)	7,250
		Break in copper layer

TABLE IX
Etching Treatments for Other Base Metals

Base Metal	Etching Treatment
Ni-Mo steel	Anodic in 25 per cent (by weight) H ₂ SO ₄ , 200 amp. per sq. ft., room temperature, 5 min.
Ni-Mo cast iron	Anodic in 25 per cent (by weight) H ₂ SO ₄ , 500 amp. per sq. ft., room temperature, 3 min.

of the test piece (a constant) and h is the deposit thickness (a variable); the area in tension = $(\pi r_1^2 - \pi r_2^2)$ where r_1 is the radius of the test piece (a constant) and r_2 the radius of hole diameter of the test piece (a variable). Applying this to the data in Table V, with a deposit thickness of 0.128", the ratio (shear area) ÷ (tensile area) is 1.07, that is, less than 1.3, and the deposit failed by shear. With this hole diameter of 0.75", as employed in the original Ollard test, the deposit would have to be at least 0.145" thick in order to obtain tensile separation. Rather than going to such a thick deposit, it is more practical to increase the ratio (shear area) ÷ (tensile area) by increasing the hole diameter of the test piece and thus decrease the area in tension. Table VI gives the data on this point.

With the low thickness value, the deposit folded at the edges, but instead of shearing, the deposit elongated as shown in Fig. 10. With the thicker deposits, folding did not take place and the narrow rim of nickel attached to the steel base stretched until a break occurred. These results indicate that the adhesion between the nickel and steel is greater than the tensile strength of the nickel.

In some previous work, the results of which were given by Wesley⁶, a tensile strength of 51,000 lb. per sq. in. was

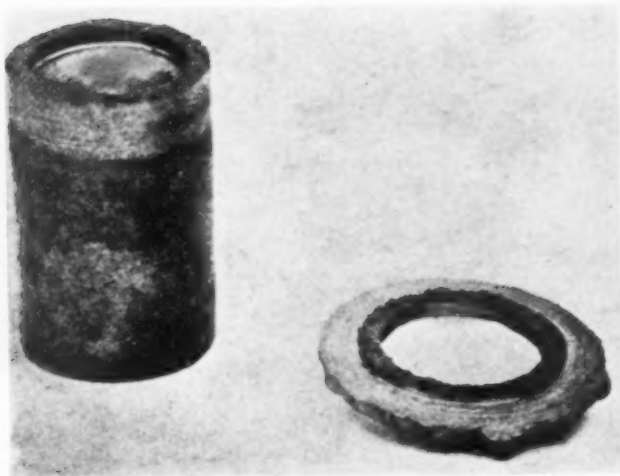


Fig. 7. Cast iron specimen after break. Twice actual size.

obtained for nickel deposited from the same bath as employed in the present work, and this value is appreciably lower than that of 85,000 lb. per sq. in. given in Table VI. In determining the tensile strength of nickel deposits, the direction of the applied load is at right-angles to the direction of crystal growth, whereas in the present case the load is applied in the direction of crystal growth. This variation may explain the discrepancy.

From these results it is suggested that the Ollard test be modified to the following specifications: 0.938" hole diameter of test piece, a 1.020" die hole diameter, with a deposit at least 0.090" thick. The plunger for applying the load should be $\frac{3}{8}$ " in diameter, and have a rounded end.

At the suggestion of T. H. Wickenden, of the International Nickel Co., the following tests were carried out. Duplicate round standard A.S.T.M. specimens were machined from nickel stock and from a nickel-chromium steel; duplicate specimens were also machined from the same materials in the form of the actual Ollard test specimen according to the above specifications. That is, the rim and body of the test specimen were formed from the same piece of metal. It was found necessary to increase the thickness of the rim on the nickel Ollard specimens to prevent cupping, and the results are given in Table VII.

If the Ollard method in its modified form gives a true tensile test, the results should agree for each metal, and it can be seen that this is the case with the nickel. With the



Fig. 8. Cast iron. Extent of etching with No. 5 treatment. Mag. 100 x

steel, however, the Ollard values are higher than the tensile strength by about 10 per cent. A safe assumption would seem to be that for nickel, the modified Ollard test has the same theoretical significance as the tensile test, and that undoubtedly an explanation can be found for the discrepancy with the steel. However, it can be stated at present that values obtained with the modified Ollard test on nickel deposits can be regarded as true tensile measurements, at least within an error of 10 per cent.

Application of Modified Test

The results obtained to this point were on nickel deposits plated from the usual type of nickel bath, and show a hardness of 160 Vickers. Since many engineering requirements call for a harder type of nickel deposit, tests were run with the modified Ollard test on deposits showing a hardness of 420 Vickers. The following conditions were employed and the results are given in Table VIII. Nickel deposits on cast iron, where the base metal may be porous, do not cover as well as copper, and so work was also included in which a thin undercoat of copper was employed.

$\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$	180 gm. per liter.
NH_4Cl	25 " " "
H_3BO_3	30 " " "

Temp. 130° F., pH 5.6 (electrometric), C.D. 50 amp. per sq. ft., 0.09" deposit thickness.

With the copper undercoat, after the break occurred, copper was found on both the cast iron and on the nickel. There seems to be no data available on the tensile strength of copper deposited from the cyanide bath, but the present results would indicate that this strength is quite low, and probably of the same order of magnitude as the adhesion values.

Adhesion of Ni to Ni

In commercial work it is sometimes necessary, in building heavy deposits, to remove the cathode before the final thickness is reached and then to replace it in the bath and continue with the deposition. In order to devise a simple procedure for such an operation, the following work was carried out.

A steel Ollard test piece was cleaned by method No. 4 (4 min.), Table II, and then nickel plated to a thickness of about 0.012" from the regular plating bath. The specimen was then removed from the bath, washed and allowed to stand in the air for 1 hr. It was then rinsed and placed in the plating bath as anode at 10 amp. per sq. ft. for $\frac{3}{4}$ hr. The current was then reversed and the piece made cathode at the same current density for 1 hr., after which the current was gradually raised to 50 amp. per sq. ft. over a 2-hr. period. It was plated under these conditions to a total deposit thickness of 0.090". The piece was then machined to give a length of 1.520" on the cylindrical surface; as the first deposit was 0.012" thick, this would mean that the applied load would tend to effect separation at both the steel-nickel and at the nickel-nickel interfaces. The adhesion value, under the modified testing conditions, was 65,000 lb. per sq. in. The break was irregular; over part of the surface at the steel-nickel interface and at other parts at the nickel-nickel interface. This method apparently gives very satisfactory adhesion.

In certain cases, such as the repair of worn parts where part of the base metal is covered with a previous nickel layer, or where it is desired to deposit nickel on a nickel base, a cleaning procedure which will give good adhesion is desirable. Such a procedure has been described by Hothersall⁷, and he was able to obtain excellent results on mild steel, Ni-Cr structural steel and nickel. The procedure has been used here as method No. 2, Table I.

In order to study this procedure in more detail, a piece of nickel was annealed for 1 hr. at 1600° F. One face was then polished, through the 400 grain wheel, and the piece plated in the regular nickel bath at 10 amp. per sq. ft., after being cleaned by method No. 2, Table I. After plating, a heavy copper layer was deposited over the whole of the piece. Fig. 11 is a cross-section through an unpolished side, Fig. 12, through the polished side. It can be seen that the deposited nickel was influenced by the grain structure of the nickel base metal through the 0.030" of the deposit. Repeated at a current density of 25 amp. per sq. ft., there was only slight indication of continuation, and at 50 amp. per sq. ft. no indication was obtained.

This condition, of reproduction of the micro-structure of the base metal by the deposit, has been realized in a number of cases by various workers in the field and represents an ideal case of perfect adhesion. Hothersall⁸ obtained continuation of nickel deposited on electrolytic nickel, and any doubts as to the possibility of obtaining this case of perfect adhesion are dispersed by the present work. From the evidence of the adhesion tests and the continuation of base metal structure, Hothersall⁸ has concluded "that when nickel is deposited on a clean, etched surface of pure iron, it follows for a time the orientation of the crystal lattice of the iron and the two metals are held together by atomic forces. With metals of commercial purity the evidence of adhesion forces, approaching or exceeding the tensile strength of the metal, suggests that this type of bonding applies generally to electrodeposits of nickel on clean surfaces."

Satisfactory etching treatments for other base metals, after the preliminary procedure already described, are given in Table IX.

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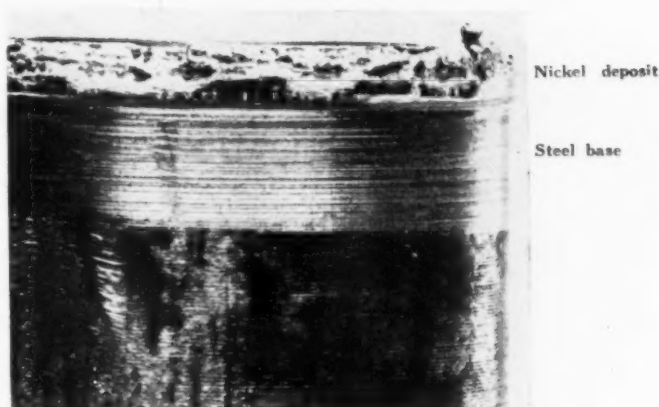


Fig. 9. Ollard test piece showing sheared deposit. Mag. $2\frac{3}{4}$ x.

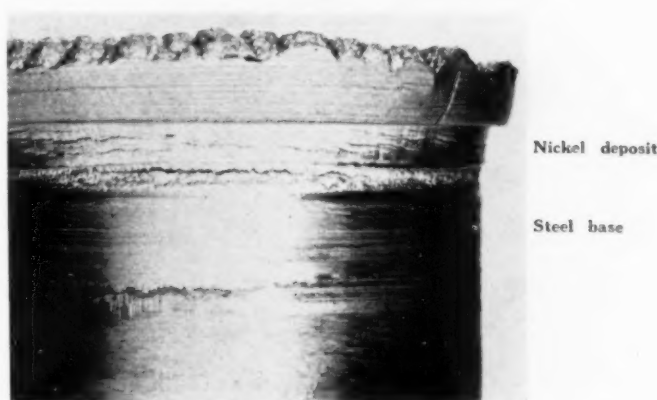


Fig. 10. Ollard test piece showing elongated deposit. Mag. $2\frac{3}{4}$ x.



Fig. 11. Nickel deposited upon unpolished annealed nickel. Mag. 100 x.



Fig. 12. Nickel deposited upon polished annealed nickel. Mag. 100 x.

American Hot-Dip Tinning Practice

4. Tinning Copper



BY WALLACE G. IMHOFF

President of the Wallace G. Imhoff Co.
Consultant in Hot-Dip Tinning
Vineland, New Jersey

General Methods

There are four general methods of tinning copper, namely, hot dipping, wiping, electroplating and spraying. At this time, the hot dipping method of tinning copper will be described in more or less detail, and the other methods will be discussed very briefly, more as a reference than anything else.

Hot Dipping Copper

Copper to be tinned by the hot dipping process, has been generally fabricated into some form or other. Before the copper base metal can be tinned properly, the surface must be prepared by degreasing, pickling and fluxing. If these processes are not properly done, the tin may wet the surface non-uniformly or not at all. Frequently, improper surface preparation results in the phenomenon known as "de-wetting." In this phenomenon, an uneven layer of copper-tin compound is formed by the non-uniform nature of the improperly prepared copper. For example, the diffusion and alloying of the tin with the copper, will be slower through a film of grease or oxide than with clean metal. A less frequent cause of de-wetting can be correlated to the specific structure of the metal to be tinned, such as possessing a hard rolled structure. Deep pickling and annealing may sometimes overcome de-wetting difficulties due to the inherent nature of the base metal.

Degreasing or Cleaning:

The copper sheet may be contaminated with drawing or forming compounds and inorganic dirt. Simple solvent

This is a valuable contribution to the sorely needed literature on hot-tinning. Cleaning, pickling and fluxing are described for preparing copper for the tinning solution. Applying of tin by wiping, electrodeposition, spraying and by hand operation is briefly outlined. Tinning of pipe, tube, wire and tape is described.—Ed.

degreasing may remove most of the organic compounds, but frequently this method leaves a film of solid dirt. Alkaline cleaning is required to clean the surface so that no water-breaks appear. There are numerous proprietary materials on the market for this purpose, and the discussion of these materials is outside the province of this paper.

Properly buffered alkalies are available which do not attack copper and which can be used for both still cleaning and electrolytic cleaning. It is important that the work be thoroughly rinsed after alkaline cleaning to prevent the drag-over of any soap films into the pickling or fluxing bath. Spray rinses are particularly valuable and efficacious.

Pickling:

If the copper is coated with a heavy oxide scale, it should be pickled in either of the following scale removal pickles.

1. Sulfuric Acid Pickle:

Sulfuric acid	1 gallon
Water	4 gallons
Temperature	150-170°F.

2. Bichromate Pickle:

Sulfuric acid	1 gallon
Sodium bichromate	2 oz./gal.
Water	4 gallons
Temperature	140-160°F.

This solution can also be used cold.

If the copper is relatively clean and bright, the nitric acid type pickles may be omitted. If pickling is desired, it can be done in either 15% by volume nitric acid used at room temperature or in the following bright dip:

Bright Dip Solution for Copper and Its Alloys:

Sulfuric acid	2 gallons
Nitric acid	1 gallon
Water	1 quart
Hydrochloric acid or salt	1 oz.

to every 5 gallons of mixture. This solution is used cold.

The hydrochloric acid or salt is used to brighten the resultant finish which is usually not necessary for dipping previous to hot dipping. If faster action is desired, the amount of water can be increased and the nitric acid can also be increased. The acids are contained in stoneware (small articles) or acid-proof brick tanks. Due to the toxic and irritating nitric oxide fumes evolved, the tanks should

be equipped with hoods with proper exhaust to carry off the fumes. Heat is generated when the acids are mixed and thus the mixing should be done slowly to avoid cracking the container. The immersion time in the bright dip or pickle is relatively short, being a matter of seconds and the transfer to the running cold water rinse should be rapid.

Fluxing:

After the work has been given the bright dip, it must be thoroughly rinsed to remove all traces of acid before it is put in the flux solution. The early tinning flux was made by "cutting zinc in muriatic acid", that is dissolving zinc in muriatic acid to obtain zinc chloride. This practical flux, however, had many disadvantages, and in recent years has been replaced by the "commercial tinning flux" of pure zinc chloride. In some still more modern plants, a tinning flux of liquid zinc-ammonium chloride is now used. It was the practice in the early days to use a little of the pure white fine ammonium chloride along with the "cut zinc chloride". Modern fluxing practice gives a purer and more accurate flux, and therefore the results are more uniform. It is extremely important that all the solutions be kept clean in each of the tanks, and that the solutions be kept fresh, and that none of the articles are exposed to the air because the baskets are too full.

The next step is the actual dipping in the molten tin bath. Tin melts at 449° F. (231.9° C.), and at 530° F. it takes on the "tin yellow" color due to oxidation. The bath temperature when tinning copper should be as low as possible, and the submersion time in the tin should also be as short as possible, since the copper is readily dissolved by the tin. In most cases, the temperature of about 520° F. will be found all right, but this may differ in actual practice because of the size of the articles, or the production, or some other factor which directly affects the quality of the finish or the manufacturing costs. The character of the work, and the conditions will quickly show the operator what temperature gives the best results. The tin should be a pure tin, preferably a good brand of "Straits" tin. These tins are soft tins, and they also give a beautiful bright tin coating. The articles must be brought to the temperature of the tin bath, and then held there just long enough to develop the highest quality finish. Either too long a time, or too short a time in the tin may cause defects of one kind or another. There is a right bath temperature, a right submersion time in the tin, and a right production for every article.

When the article has been in the tin bath the correct time, it is then slowly withdrawn, and handled in such a way that the tin will drain off smoothly, and the coating will be uniform, and no drip will be left. In order to set the tin coating the piece is quenched in a kerosene oil bath surrounded with a running water jacket to keep the oil cool. From the oil, the articles go to a sawdust drying treatment, after which they are sent for inspection.

Wiping

Daniels and Macnaughtan have the following to say about the wiping process¹ of tinning copper—"The tinning of copper by the two tin wiping processes that are frequently used has been described in detail by Krom² and Monroe³. In one method, molten tin is poured over the article, which has previously been coated with zinc chloride solution, by rubbing with a mop soaked with this solution. In the other

method, pieces of block tin are melted directly on the surface of the previously heated and fluxed article. In both cases the tin is smoothed all over the surface with a piece of tow (rope, waste) whereby excess is wiped off. The coatings obtained by these methods are liable to be uneven. When much time is spent in the operation, the coating is richer in content of dispersed tin-copper compound, and is consequently somewhat harder than that provided by the hot-dipping process. In general, such coatings are not so resistant to corrosion as the latter."

Electrodeposition

The same authorities¹ state that electrodeposition is also used for the coating of refrigerator parts. This has become possible as a result of improvements in methods for the electrodeposition of tin. In particular, plating solutions are now available which possess a throwing power sufficient to ensure deposition of the metal in the deep recesses in the most complicated refrigerating units. The essential constituent of these baths is sodium stannate.* The bath requires to be worked hot, about 70 degrees C. In general, the rate of deposition is such as to deposit about 0.001" per hour.

Spraying

This is effected¹ by feeding tin, in the form of wire, into an oxyhydrogen flame at a regular pace, whereby the metal is melted and sprayed as minute particles on the surface to be coated. The coating, which consists of a large number of solidified drops, is liable to be porous. By spraying a number of coats, each coat being scratch-brushed before the next is applied, the porosity may be considerably diminished⁴.

Tinning of Copper Sheets⁵

Since a somewhat different technique in regard to detail is used in hot-dip tinning various kinds of copper articles, a general description will be given, and the references cited can be consulted for the full details.

Copper sheets are often tinned by hand operations. The tin mixture is melted in a cast iron pot. The copper sheets are cleaned and pickled prior to the tinning process. They are then rubbed with a fluxing solution of zinc chloride and hydrochloric acid. The operators lay them, one by one, on an inclined table adjacent to the pot. A ladle of molten tin is emptied and caused to flow over the sheet, the excess running back by troughs into the pot. Then, beginning at the top, the sheet is wiped off with a brush or bundle of tow to remove the excess tin. In this manner, a smooth, even coating is produced.

In another method, the cleaned, and pickled sheet is laid on a bench which contains an inset gas grate flush with the top, or else the sheets are heated in a furnace preparatory to tinning. In the first method, the sheet is passed over the grate and heated. The operator takes small flat pieces of tin of a calculated and weighed amount, lays them on the heated sheet, allows them to melt, and rubs them into the copper sheet when they have melted. The flux employed is usually dry powdered ammonium chloride. In the second method, weighed quantities of tin are dropped on the heated sheets

*See page 39 of 1940 "Plating and Finishing Guidebook"—Ed.

as they come from the furnace. As the tin melts, it is brushed on to the sheets by means of bundles of tow or brushes as rapidly as possible, and spread over the whole surface of the sheet. Manufacturers claim that this method gives a more uniform coating than when molten tin is caused to flow over the sheet.

Tinning mixtures containing a small amount of lead are often used, as it is claimed that the latter exerts no harmful effect provided the material is not used in containers for foodstuffs or liquids for drinking purposes, but that the lead has the advantage of increasing the fluidity of the mixture.

Daniels⁶ states, "For thin copper sheet, the range of dipping temperature giving a smooth coating with tin containing 1.1 per cent of copper was found to be 240-280° C. With increase in copper it appears that the lower temperature must be raised."

Tinning of Copper Pipes and Tubes^{1, 7, 8}

Tinned copper pipe finds application in refrigeration equipment. Usually, the coating is obtained by hot-dipping, which may be effected by immersion in tin by a procedure similar to that previously referred to. After removal from the molten tin, the pipes are allowed to drain. In the case of pipes of medium and large bore, smoothing of the interior coating is frequently effected by pushing a cork bung of suitable size through the interior. The outside is smoothed by rubbing with tow. The tinning may be confined to the interior of the pipe by flowing the molten tin through the previously cleaned and fluxed pipe. The latter method is also used for the production of tinned lead pipes. As the coatings produced in this way are thin, there is a risk of the exposure of copper and lead as the result of corrosive attack, abrasion, or scratching. This may result in injurious contamination of foodstuffs, which is particularly objectionable in the case of lead. Lead pipes however, may be provided with a relatively thick lining of tin by extrusion. For certain applications all risks of contamination of foodstuffs by lead and copper may be avoided by the use of block tin pipe. This pipe consists entirely of tin, produced by extrusion. The applications of such tinned pipe are for milk coolers, chilling of beer, chilling of soda water, ice cream, and domestic refrigerators.

Daniels and Pettis^{7, 8} describe the tinning of copper tubes as follows—"The tin pot is a flanged cast iron trough, U-shaped, about 10 inches wide across the top, 7 inches deep and many feet long. A V-shaped wooden trough of the same length is used for fluxing.

The tubes, having been dipped in the solution of zinc chloride, used as a flux, are allowed to rest at an angle, to drain off surplus solution. The tinner and his helper then lift it by inserting iron hooks in the ends and slowly lower it, one end first, into the tin which is kept at about 270° C. (518° F.). On removal from the tin, one end is held high to allow the tin to run out of the tube back into the bath, and the tube is then transferred to the wiping rack. This is a wooden horse about two and a half feet high, on one end of which the tube rests. The other end rests on the floor. The tinner holds the tube firmly with a pair of tongs which grip the inner and outer walls at the top end, and the wiper rapidly draws pieces of tow, one held in each hand, down the outside of the tube. The inside is then wiped, either by thrusting a rod, with one end wrapped in tow, through the

tube, or, in the case of smaller tubes, by pushing a snugly fitting cork through the bore⁹. Wooden rods are used to avoid scratching the coating. The addition of about 8-10 per cent of lead to the tin makes the wiping operation easier. For use in contact with foodstuffs, milk, beer, etc., however, it is necessary to avoid the presence of lead in the tin coating. When the insides only of the tubes are to be tinned, the outsides are coated with distemper. (A pigment mixed with a vehicle solution in water)

Tinning Copper Wire^{10, 11, 12, 13, 14, 15}

According to the Iron Age, September 7, 1939, page 39, the bright annealing and tinning of copper wire continuously in strands has been made practical through a new joint development by the Syncro Machine Co., New York, and the Surface Combustion Corp., Toledo, Ohio.

Referring to the accompanying illustration, the wire is unwound from the spool at the right, passes over a push-pull capstan, through a mechanical cleaner, and then through the annealing chamber. For tinning, the wire then passes through a chlorine fluxing agent. Fluid tin is uniformly applied under pressure by means of a unique construction of jets. The tin is entirely enclosed, reducing oxidation losses to an absolute minimum. Excess tin is retrieved and the wire burnished to a high lustre as it leaves the tinning zone, by a self-cleaning wiping device.

Quenching takes place in circulating water, the excess water being removed by a highly efficient vacuum wiper. The wire then passes through a visual indicator which constantly shows and controls the degree of anneal. This device makes possible extremely accurate and uniform control in obtaining the desired percentage of elongation.

The take-up is motor driven and provided with a traverse. The spool drive automatically maintains correct tension throughout the filling of a spool. The spooling tension can be adjusted while the unit is in operation.

The unit can be used for either tinning or straight bright annealing. The annealing chamber consists merely of special open flame burner with a sheet metal hood as a protection against drafts.

The flame is continuous and up to 27 ft. long depending on the gauge of the wire. The burner is specially constructed to produce a flame of uniform height along its entire length. The wire is carefully guided through the reducing portion of the flame so as to eliminate oxidation. This principle of bright annealing is the same as used in the large continuous direct-fired furnaces for annealing wire in coils and in which the burners are set slightly rich so as to produce a reducing atmosphere.

The elimination of an expensive furnace and other contributing factors is said to make this method of annealing or annealing and tinning copper wire, drastically cheaper than any other method.

One of the most practical discussions on the hot-dip tinning methods for coating copper has been given by Dr. P. Siebe. The general wire tinning is effected on the continuous production system. The wire situated on the reel runs first into a pickling bath after which it is rinsed and then passes into a bath of flux. It then runs through the tinning bath, is wiped on leaving, and then immediately rinsed in running water. A drying arrangement is connected, and the wire is wound after being dried.

The wire is bright annealed before being tinned. This

necessitates a light pickling and effects a smooth surface for the tin to be deposited on, and at the same time gives a greater uniformity in the thickness of the coating. The pickling bath consists of dilute sulphuric acid, about 5 per cent. At the end of the acid bath a wiper board covered with cleaning cotton waste is arranged so that it removes the greater part of the acid adhering to the wire. The wire then passes into the rinsing bath which should contain soft water to prevent the formation of salts. From the rinsing bath, it passes into the flux solution. This is a zinc ammonium chloride solution. After being again wiped to remove the excess flux, the wire enters the tinning bath. The tin pot is an iron pot from 39 to 59 inches long. The furnace is so constructed that the tinning bath can be readily controlled in temperature. Only the purest tin should be used; a soft "Straits" tin is desirable. The tin bath is also covered with a flux of zinc ammonium chloride with a small quantity of rock salt (about 70:20:10); rosin and tallow are also used. The quality of the flux can be judged by the clearing of the surface as the wire is introduced.

The delivery of the wire should be kept free of all flux particles. The wiping device must be arranged according to the thickness of the wire and the thickness of the coating to be applied, namely with thin wires close to the surface of the bath and with thick wires somewhat farther from the surface of the bath. The wire is usually wiped with rubber plates prepared in a suitable manner with asbestos; cork wiping surfaces are also used for thin wires. The pressure of the wiping is determined in the first instance by the thickness of the tin coating. After leaving the wiper the wire is immediately rinsed in running water. In this case also, particular care must be taken in regard to cleanliness and low degree of hardness of the water. The water rinse is to a great extent responsible for the brightness of the tin coating. In the case of thick wire, a drying is further obtained by passing the wire between the two superposed cotton waste bars. After this the wire is wound or spooled.

The ordinary tinning bath temperature is at 260° C. (500° F.) which can be slightly lower for thin wires and slightly higher for thick wires. Overheating the tin bath, apart from spoiling the quality of the tin, has very disastrous results. Excess oxide and tin dross both are formed. The tin dross is a copper alloy which may contain as much as 25% copper and deposit out in large quantities on the bottom of the tin bath. The tin dross is removed with a perforated dross scoop.

The speed through the tin bath is determined by the thickness of coating desired, and by wiping. The speed is also determined by the thickness of the wire being tinned. This varies slightly in different plants. The thickness of the coating for a 1 mm. wire is about 1.2% of the wire weight. If specified, the wire may be tinned twice.

Daniels also gives a description of the tinning of copper wire which is essentially the same as that just given. He mentions porcelain pulleys may be used for conducting the wires through each operation. Also he states there is a wide variation in the composition of the flux used. The usual zinc chloride or zinc ammonium chloride solutions are tending to be replaced. In some plants a solution of stannous chloride and glycerine, to which a little ammonium chloride may be added, is used. In some plants a polished chromium-steel shoe has been used to submerge the wires; in others the steel wheel is generally employed. The wires

pass vertically up and out of the bath, through a suitable wiping device which removes the excess tin, and continue to a sufficient height to allow the coating to set before passing over a pulley and down to the coilers. Thick wire may be given an additional water cool immediately before reaching the take-up reels.

The wipers generally are made of asbestos string which has been dipped in molten tallow. A short length of this is wound tightly three times around the wire in a close spiral and knotted firmly in place. It is then allowed to pass on the wire through the tin and is brought to a stop against the wiper bar, which is fixed about a foot above the tin surface. The weight of coating produced is determined by the speed of the wire, the temperature and composition of the tin, and the distance the wire passes before passing through the wiper.

The tin should be pure. Contamination with copper during use is, of course, inevitable, but will not be serious unless the bath is worked at too high a temperature. The tin pot may be of welded mild steel or of cast iron, and should be heated with gas or electricity with automatic temperature control. The temperature of the tin bath is generally about 250-265° C. (482-509° F.). When the time of immersion and the temperature of tinning and the activity of the flux (which is a contributory factor) are suitably adjusted, it is possible to maintain the copper content of the bath at a satisfactory figure, dilution on adding fresh tin keeping pace with the formation of copper-tin compound. If for any reason, too much copper is absorbed, it will be necessary to cool the bath to crystallize it out, so that it can be removed with perforated ladles.

Some authorities state that the tin surface should be protected against oxidation by the use of a flux cover. Mixtures of zinc chloride, stannous chloride and sodium chloride (80:10:10) or zinc chloride, ammonium chloride and sodium chloride (70:20:10) have been suggested for this purpose. Rosin and tallow have also been used. In many cases, however, the tin is left uncovered. Loss of tin by oxidation is not serious if the temperature is kept low, and if the metal is free of impurities, particularly iron and zinc.

Tinning Thin Copper Tape¹⁶

In discussing the proper conditions for tinning thin copper tape, attention has been called to the trouble as being due to the fact that the tin was not wetting the copper, but gathered in drops instead of spreading uniformly. The cause of the defective coating was found to be due to improper cleaning of the tape. Electrolytic cleaning, either in a 2% sodium carbonate, or 3% sulphuric acid solution at 6 volt D.C. supply, immediately gave a perfect tin coating. The deposit of the tin in drops was due to the copper surface not being properly cleaned.

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A.S.T.M. Discusses Corrosion At Spring Meeting in Washington

A.S.T.M. COMMITTEE ON CORROSION OF IRON AND STEEL REVIEWS ITS EXTENSIVE EXPOSURE TESTS ON ALL TYPES OF PRODUCTS AND INITIATES NEW WORK

Results of the periodic inspections of many of its country-wide research projects were studied at the meetings of A.S.T.M. Committee A-5 on Corrosion of Iron and Steel held in Washington, D. C., March 3 to 7, during Committee Week and decisions were reached on publishing these data. The committee also studied specifications in its charge covering zinc coatings and other protective coated materials—strand, wire, shapes, and the like. Several new projects are to be undertaken as indicated in the resume of the committee's activities which follow.

Subcommittee III on Inspection of Annapolis Tests is still continuing the exposure tests of black uncoated iron and steel sheets started in 1915 at Annapolis, Md. An inspection of the sheets was made last October and several new failures noted which will be covered in the 1941 annual report of the committee. During the past year, the Navy Department found it necessary to use the site on which the test racks were located which required their removal to a new location adjacent to the old site. This was accomplished without damage to the test specimens; the new site has substantially the same atmospheric exposure conditions as the old.

Subcommittee V on Total Immersion Tests has in its charge the test specimens of riveted plates which have been removed at Portsmouth, N. H., and those at Key West which will be removed shortly. A final inspection of these plates and a report will be made, but not in time to be included in the 1941 annual report. The pipe specimens, including both low and high copper content, removed last spring have been cleaned and examined. A report on these prepared by V. V. Kendall is now being edited by the subcommittee and will be presented this year at the A.S.T.M. Annual Meeting, June 23 to 27, inclusive, in Chicago. The exposure tests in sea water of all sheet, pipe and plate specimens are now completed. A final report covering all the works of the subcommittee to date will be prepared sometime this year.

Subcommittee VI on Specifications for Metallic-Coated Products proposed to recommend the adoption as standard of the two tentative specifications covering zinc-coated iron or steel wire strand (A 122) and zinc-coated steel wire strand (A 218).

The subgroup reviewing the tentative specifications for zinc-coated iron and steel sheets (A 39-38 T) is attempting to reconcile differences between these specifications and the Federal specifications on these same products.

B. J. Barmack, Commonwealth Edison Co., has been appointed chairman of a subgroup to prepare new specifications for zinc-coated iron and steel hardware materials. The organization of this section is actively under way at the present time.

The 1941 report of Subcommittee VIII on Field Tests of Metallic Coatings will cover principally the atmospheric exposure tests on zinc-coated wire materials including straight wire, woven wire fencing, barbed wire and chain-link fencing. These materials have been ex-

posed since 1936 at eleven locations. Corrosion of some of the materials has now progressed far enough at several locations to permit drawing some preliminary conclusions. It was found necessary this past year to remove the test rack at Key West because the Navy required the use of the land on which our rack was located. The rack and all test materials were relocated on a satisfactory site made available on the Army reservation at Key West.

The exposure tests on zinc-coated and protective coated hardware samples have been completed on a large majority of the samples at all locations. The materials still remaining under test consisting principally of hot-dip zinc and aluminum coated samples are to be assembled on a section of the test rack at each location and the test on these materials continued. No report on the results secured to date in the hardware exposure test will be made this year, but a full report will be made in 1942.

Investigation of the unusual failures of zinc coatings on sheets at Key West mentioned in last year's subcommittee report is still continuing. Several sheet specimens showing this type of failure will be removed from the racks at Key West for closer study and possibly microchemical analysis in the laboratory of the corrosion products.

The foregoing unusual failure of zinc coatings and other peculiar failures under certain service conditions has suggested the possibility of a correlation between such failures and the chemical composition of the zinc coating on the failed specimens. Subcommittee VIII has already made a preliminary study of the analytical problems involved and has appointed a section to work with the National Bureau of Standards in developing proper analytical methods before proceeding further in their analysis of the zinc coatings on the materials exposed.

The subcommittee on field tests has been asked by the subcommittee on specifications to determine what effect increasing the present aluminum limit of 0.01 per cent in zinc baths for galvanizing structural steel, etc., would have on the atmospheric corrosion resistance of zinc coatings produced from such higher aluminum content baths. Subcommittee VIII is preparing a number of small hand-dipped zinc-coated sheet specimens with various percentages of aluminum in the coating baths for exposure at one of their test locations. It is hoped that these tests can be started within the next few months.

Officers of Committee A-5:

Chairman: W. H. Finkeldey, member of firm, Singmaster & Breyer.

Secretary: T. R. Galloway, Structural Engineer, Mechanical Engineering Dept., Consolidated Edison Co. of New York, Inc.

CORROSION TESTS REVIEWED BY A.S.T.M. COMMITTEE B-3 ON CORROSION OF NON-FERROUS METALS AND ALLOYS

Several reports of its subcommittees were studied by A.S.T.M. Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys at its Washington meeting during Committee Week, March 3 to 7. The Subcommittee on Total Immersion Tests had reviewed the re-

(Concluded on page 203)

Surface Tension Measurements

PART I

BY DR. C. B. F. YOUNG[†] and E. S. ROSZKOWSKI[‡]

The authors review methods for measuring surface tension of liquids. In Part I are included the capillary tube method, the stalagmometer method and the burette type method.—Ed.

Introduction

THE field of electroplating is primarily concerned with the preparation of base metals and the deposition of metallic coatings thereupon. At first glance the field or fields indicated above appear to be rather narrow. However, if one investigates, it will be found that these narrow fields encompass a large area of scientific studies. For instance, the subjects metallurgy, metallography, chemistry, organic chemistry, electricity, physics, mechanics, etc. are used many times by the plater to solve problems arising in the production of better electrodeposits. It has definitely been shown in the last few years that surface tension of plating and cleaning solutions can play an important part in the cleaning of metals and the deposition of many electrodeposited coatings. For instance, in the plating of nickel it is possible to prevent pits in the deposit by adding a small amount of different organic compounds which lower the surface tension of the solution. These materials prevent bad deposits, as mentioned above, when these imperfections are caused by the adherence of minute bubbles of hydrogen to the cathode. If the surface tension of the bath is lowered, the adhering gas is released from the surface of the cathode and a good plate is obtained where heretofore an imperfect one had been produced. Thus, it is important that the electroplater understand thoroughly the mechanism involved in determining surface tension of solutions and some methods for measuring surface tension applicable to the plating plant.

There are several objections to the standard method of determining surface tension, if it is assumed that the ring method is the standard. One of these is cost of the instrument. Another is the technique and time involved in obtaining checking data. This being true, the authors have endeavored to compare with the standard or ring method, two other types, namely, the drop and capillary methods. In order to make the surface tension method within the reach of all plating plants, ordinary laboratory apparatus was used as much as possible in some of the methods. The results obtained have been compared to the standard method and it has been found that good correlation can be obtained provided proper precautions are taken when calculations are made. The authors have taken into consideration the work done on this subject and have given simple methods, applicable in the ordinary plating plant, for determining

constants for the ring and stalagmometer methods. It has been found that our drop and capillary method needs no correction whatsoever.

Nature of Surface Tension

Surface tension is the resultant of forces which act on the molecules in the surface layers. Molecules of a given material have certain constant forces of attraction acting between them. Thus, molecules inside of a given mass have molecules that attract them on all sides. On the other hand molecules at the surface do not have molecules that attract them on all sides. On the side away from the mass there is no force of attraction due to the absence of molecules. Directly opposite this side on the surface molecules there are forces of attraction which pull the surface molecules into the mass of material. This resultant force acting on the surface of the material will force the material to tend to assume the smallest surface possible.

There are two types of liquids in a given container that could possibly exist. Those which wet the container and those which do not. These effects are clearly shown by capillary tubes. In the case of a liquid which wets the capillary, the level of the liquid inside the capillary tube will rise above the level of the liquid in the reservoir. On the other hand in the case where the material does not wet the capillary, the level of the liquid in the capillary will fall below the level of the material in the reservoir. This is clearly explained by the fact that two types of attractive forces are in existence. Those which act between similar molecules (two of the same substance) known as cohesive forces while those which act between two dissimilar molecules are known as adhesive forces. When the adhesive forces are stronger than the cohesive forces, the liquid will wet the capillary. On the other hand, if the cohesive forces are stronger than the adhesive forces, the capillary will not be wetted. These statements can be proved by the solution of the diagrams of the forces which act at the contact of the surface with the container. An example of a wetted pair is water and glass, while mercury and glass is an example of an unwetted pair of materials.

Surface tension is determined in terms of dynes per centimeter. The simplest method would be the measurement of the force necessary to stretch a given film which is supported on a rectangular frame as shown in Figure 1:

[†] Adjunct Professor, Chemical Engineering Dept., Brooklyn Polytechnic Institute, Brooklyn, N. Y.

[‡] Graduate Student, Chemical Engineering Dept., Brooklyn Polytechnic Institute, Brooklyn, N. Y.

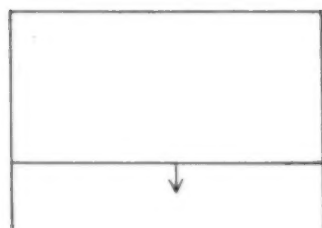


Figure I

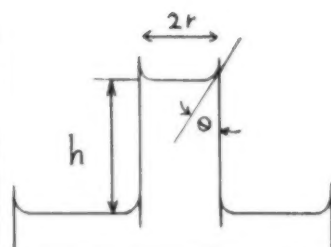


Figure II

In this case, two surfaces are being stretched, one on either side of the frame. Thus, the surface tension is equal to the force exerted divided by twice the length of the movable support. Proper units must be used.

Among the various methods used for the determination of the surface tension the outstanding ones are the capillary tubes, the stalagmometer, and tensiometer. The tensiometer is the most used of the three.

Capillary Tube Method

Capillary tubes¹ can also be used to determine surface tensions. The diagram in Figure II represents the equilibrium condition of a liquid which wets the capillary tube. The liquid rises in the tube and makes an angle of contact of θ with the tube. This angle, as measured, is the angle formed by the wall and the tangent to the liquid at the point of contact at the wall of the capillary. The force of the surface tension will act on a line which is colinear with this tangent. Since the forces acting on a horizontal plane cancel each other, the only forces which enter into effect are the vertical ones. Thus, the surface tension is equal to

$$2\pi \cdot r \cdot \gamma \cdot \cos \theta$$

since the plane of the liquid glass contact is the level of action of the forces. The weight of the liquid lifted by the surface action is $\pi \cdot r^2 \cdot h \cdot d \cdot g$ since units of the same system must be used. Thus:

$$2\pi \cdot r \cdot \gamma \cdot \cos \theta = \pi r^2 \cdot h \cdot d \cdot g \text{ and } \gamma = \frac{r \cdot h \cdot d \cdot g}{2 \cos \theta}$$

Generally for all aqueous solutions θ is so small that $\cos \theta$ equals approximately 1.

Thus:

$$\gamma = \frac{\pi r^2 \cdot h \cdot d \cdot g}{2 \pi r} = \frac{r \cdot h \cdot d \cdot g}{2}$$

Where:

- γ = Surface tension in dynes/cm.
- r = Radius of capillary in cm.
- h = Height of rise of liquid in capillary in cm.
- d = Density in g/cc.
- g = Gravity, 980 dynes/cm²

A commercial instrument which utilizes this effect consists of two parallel tubes one of which is a capillary tube and the other is of such a diameter so that the surface of the liquid in this tube will be perfectly horizontal and flat except around the rim. The difference in the height of the two levels gives "r" and "h" necessary in the above equations. The accuracy of this piece of apparatus depends on

1. "Outline of Theoretical Physical Chemistry", 6th Ed., Getman & Daniels, p. 48.

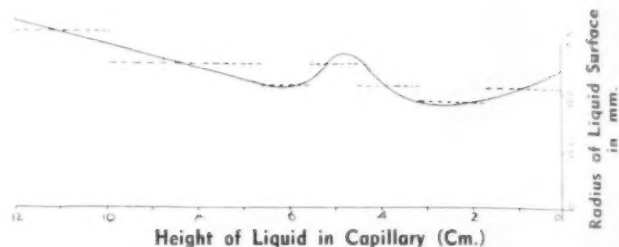


Fig. III. Radius of liquid surface as a function of height from differentiated data of the volumes of the capillary at different heights.

the extent to which the surface of the liquid in the thicker tube is flat.

Instruments of this kind are rather rare. To show the correlation of the capillary measurements with the other type of data a capillary was constructed. A glass tube was taken and when heated to the softening point was drawn into a fine bored tube which is called a capillary. Because the radius of the capillary was not known and the constancy of this radius was doubtful, a calibration curve was developed.

In the development of the calibration curve, the capillary which had been previously weighed, is filled with water from the bottom to different lengths from the bottom and again weighed. The difference in weights will give the weight of water in the capillary at the different heights when the capillary is filled from the bottom to the particular height. Since the density of the water is known, the volume of the capillary from the base to the different points can be obtained. Differentiating the data of the volumes, the radius at any point can be obtained. (Fig. III.)

Sample Calculation

Weights of capillary vs. height when filled with different amounts of water.

Height of Water	Weight in Grams
0 cm	0.847
1.746	0.871
2.91	0.886
4.52	0.905
5.52	0.921
6.64	0.937
9.92	1.002
12.00	1.069

$$\Delta H = 1.746 - 0.00 = 1.746 \text{ cm.}$$

$$\Delta w = 0.871 - 0.847 = 0.0024 \text{ gm.}$$

since density of water is 0.998

$$\Delta v = \frac{\Delta w}{d} = 0.0024 \text{ cc.}$$

$$\text{since } \Delta v = \pi r^2 \cdot \Delta H$$

means radius over this length

$$r = \sqrt{\frac{\Delta v}{\pi \cdot \Delta H}} = 0.0209 \text{ cm.}$$

Continuing this type of calculation for the rest of the data, a table will be obtained giving the mean radius between the heights involved in the capillary. Further, the radius at any particular point will be obtained by integrating the differentiated data as shown in Figure III. It must be kept in mind that the calibration of the capillary is good only for that particular capillary. This data cannot be used for any other capillary, but by following the same procedure, any other capillary can be calibrated.

The next step is the obtaining of the surface tensions using this calibrated capillary. It has been shown that for capillary tubes,

$$\gamma = \frac{r \cdot h \cdot d \cdot g}{2}$$

It is seen from this equation that for any given height of liquid in the capillary, the factors r , h and g will be constant. It was decided to incorporate these factors into an overall constant so that the relation will finally become $\gamma = K \cdot d$. K will not necessarily be a constant and may vary to a certain extent so that a more nearly correct form of the above relation will be $\gamma = f(h) \cdot d$. It was further decided to represent the factor $f(h)$ graphically. If the liquid in the tube is raised 2 cm. above that in the container or the base of the capillary from Figure III, the radius of the surface of the liquid will be 0.0138 cm. Thus, $\frac{1}{2} h \cdot g \cdot r$ becomes 13.42 units and will be represented as the $f(h)$. Continuing similarly for the entire length of the capillary, a curve will be obtained as shown in Figure IV.

From this figure, the surface tension will be obtained by first finding the height that the liquid is raised in the capillary, finding the relative value of $f(h)$ which is coincident with this point on the curve and multiplying this value by the density of the liquid. It must also be kept in mind that this curve holds only for the capillary that we have been using. Following a similar procedure, a curve will also be obtained which will be suitable for the capillary that is being worked with.

For the purpose of this paper, a solution of $K_2Cu(CN)_3$ of 7.54 oz./gal. of $Cu(CN)$ (no free cyanide) and a solution of $NiSO_4 \cdot 7H_2O$ of 28.1 gm./gal. are used. These solutions are then diluted to give 0, $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of this concentration. The densities (Fig. V) of $K_2Cu(CN)_3$ had to be determined as they have not been given in literature. On the other hand, the densities of $NiSO_4 \cdot 7H_2O$ solutions (Fig. VI) are given in standard handbooks².

Densities of $K_2Cu(CN)_3$ as Determined with a 5 cc. Pycnometer

CuCN Con. in oz./gal.	0	2.4	4.8	7.2	9.6
Weight in grams	9.4447	9.5810	9.7347	9.8639	10.0329
Sample calculation at 0 concentration:					
Wt. of pycnometer and sample	9.4447				
Wt. of " alone	4.4568				
Thus wt. of 5 cc. sample	4.9879				

4.9879

Thus, specific gravity = $\frac{4.9879}{5} = 0.9976$

5

Observations of the Heights to which the Standard Solutions in the Capillary is Raised

$K_2Cu(CN)_3$		$NiSO_4 \cdot 7H_2O$	
Height	Conc. of CuCN oz./gal.	Height cm.	Conc. of Hydrate oz./gal.
6.57	0.00	6.57	0.00
6.52	1.89	6.38	7.03
6.18	3.77	6.31	14.05
6.13	5.66	6.23	21.08
6.11	7.54	6.14	28.10

Sample calculation of surface tension:

$CuCN = 1.89 \text{ oz./gal.}$

$h = 6.52$ $f(h) = 67.1$ (from Fig. 4) $d = 1.021$ (from Fig. 5)

Thus, $\gamma = 67.1 \times 1.021 = 68.7$

Completing calculation for the rest of data gives curves labeled in Figures VII and VIII.

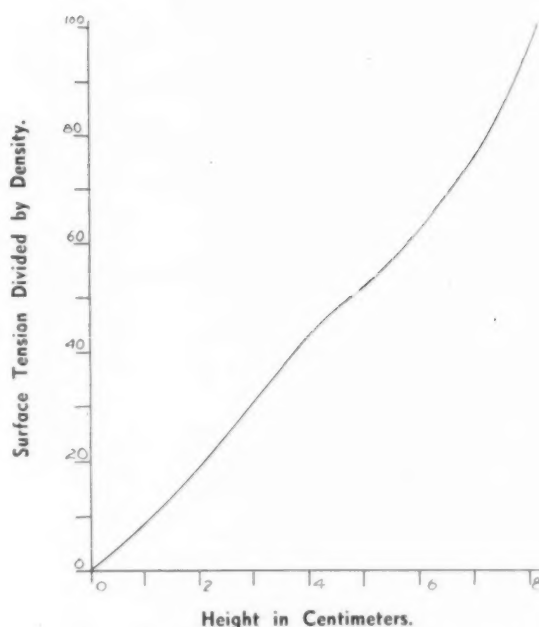


Fig. IV. Surface tension divided by the density as a function of the height of liquid in the capillary.

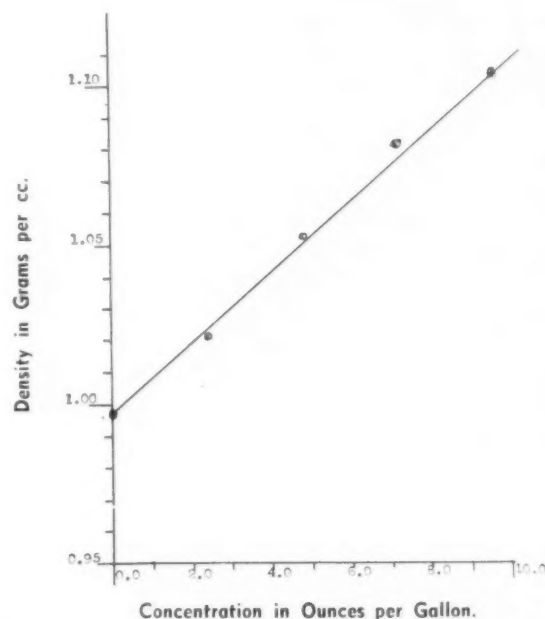


Fig. V. Density of $K_2Cu(CN)_3$ at 20° C. as a function of the concentration. No free cyanide is present.

Stalagmometer

An instrument of more extensive use in the industry is the stalagmometer. Essentially, it is an instrument from which a definite volume of a given liquid is allowed to drop³. The drops are allowed to form on a clean flat surface as they flow through a capillary tube which serves to control the rate of flow. As the drop increases in size, the weight increases with the volume. When the mass of the drop exceeds the surface tension holding the drop to the surface, it will fall off. The weight of the drop is equal to the surface tension, which is equal to the forces acting on the circumference of the rod upon which the drop forms or:

2. "Chemical Rubber Handbook", 19th Ed. p. 1011.

3. "Laboratory Manual of Physical Chemistry", Mack & France, 2nd Ed.

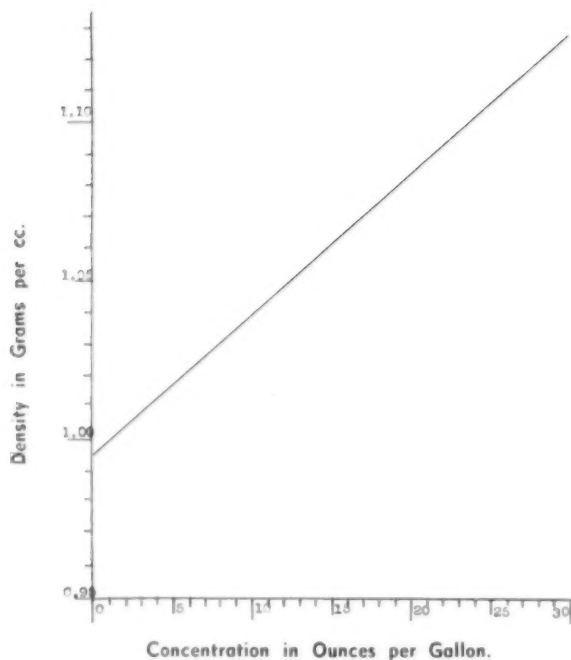


Fig. VI. Density of $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ at 20°C. as a function of the concentration.

$$m \cdot g = 2\pi \cdot r \cdot \gamma$$

$$\text{Thus: } \gamma = \frac{m \cdot g}{2\pi \cdot r}$$

m = weight in grams
 g = gravitational units
 r = radius of the outside of the rod

The drops, as they break, generally do not fall off in their entirety. Due to the physical constants of the liquid involved, only portions of drops formed at the capillary tubes fall off. In Figure IX, the relation between portion of drop formed that falls, the radius of tube, and volume of drop falling, is given⁴. It has been found that the portion of drop falling off is some function of the ratio of the tube's radius to the volume of the drop to the 1/3 power.

Thus:

$$m \cdot g = 2\pi \cdot r \cdot \gamma \cdot f\left(\frac{r}{V^{1/3}}\right)$$

or

$$\gamma = \frac{m \cdot g}{2\pi \cdot r \cdot f\left(\frac{r}{V^{1/3}}\right)}$$

The stalagmometer used had a tip, as shown in Figure X, upon which the drops formed. Although the volume of the drop formed could be determined, the radius of the capillary could not be obtained by any simple method. Thus, the relation shown above could not be used. The instrument as delivered by the manufacturer has been calibrated to deliver a given number of drops for a given volume of distilled water at 20°C. This value is 51.53 drops.

Work has been performed so as to correlate the readings obtained by this instrument⁵. This relationship is given below:

4. Harkins and Brown, *J. Am. Chem. Soc.* **41**, 519 (1919).
 5. "Plating and Finishing Guidebook", 1940, p. 65-69.

$$\gamma \text{ Liq.} = \frac{\text{Drops of H}_2\text{O}}{\text{Drops of liq.}} \times \frac{\text{Specific Gravity (liq.)}}{\text{Specific Gravity (H}_2\text{O)}} \times \gamma \text{ H}_2\text{O}$$

Specific gravity of water = 0.998
 $\gamma \text{ H}_2\text{O} = 72.75 \text{ dynes/cm.}$

Thus:

$$\gamma \text{ Liq.} = \frac{51.53}{0.998} \times 72.75 \times \frac{\text{Specific Gravity (liq.)}}{\text{Specific Gravity (liq.)}}$$

$$= 3740 \times \frac{\text{Drops of liquid}}{\text{Drops of liquid}}$$

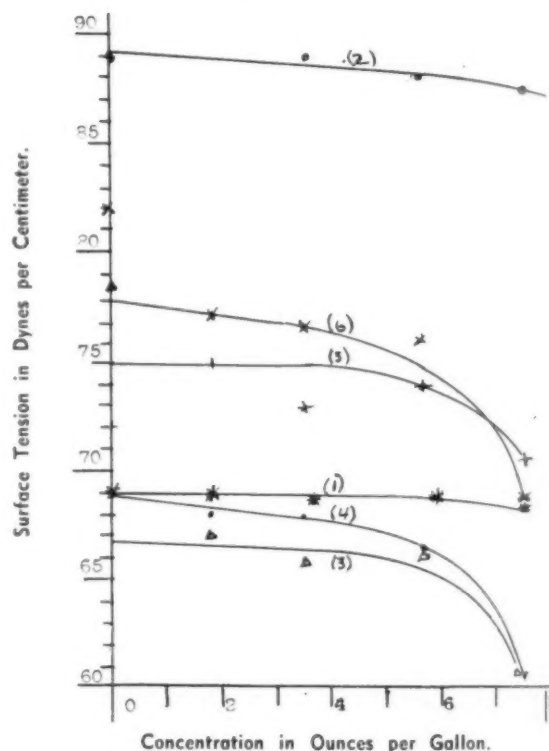


Fig. VII. Surface tension as observed for $\text{K}_2\text{Cu}(\text{CN})_4$ solution as a function of concentration at 20°C. No free cyanide is present.

Curve No.	Point	Method
1	*	Capillary
2	o	Traube Stalagmometer
3	Δ	Burette
4	•	Du Nuoy tensiometer
5	+	Balance with platinum ring
6	x	Balance with nichrome ring

Brightening Electro-Tin Deposits

The research referred to in the article of the above title, and which appeared on page 131 of the March 1941 issue of *Metal Finishing*, under the name of Garson A. Lutz, was conducted by John S. Nachtman during or prior to the year 1939. Mr. Nachtman left the employ of the Blaw-Knox Co., Pittsburgh, Pa., on May 1, 1940, and any improvements in the process of producing bright tin plate discussed in Mr. Lutz' article are, according to the information which we received, the property of Mr. Nachtman. Subsequent to the severance of Mr. Nachtman's relation with Blaw-Knox Co., Mr. Lutz remained in the employ of the company until March 1, 1941, but during this period he was not engaged on any researches connected with the process described in the article.

The article in question was submitted to *Metal Finishing* without the knowledge of any responsible party connected with the Blaw-Knox Co., and the statements contained therein have no relation whatever to the employment of Mr. Lutz by the Blaw-Knox Co., after the departure of Mr. Nachtman on May 1, 1940.—Editor.

Voltage Loss In Electroplating Bus Bar

CROSS SECTION OF BUS BAR IN SQUARE INCHES

BY CLARENCE E. BERGER

Asst. Chief Engineer,

Hanson-Van Winkle-Munning Co.,

Matawan, N. J.

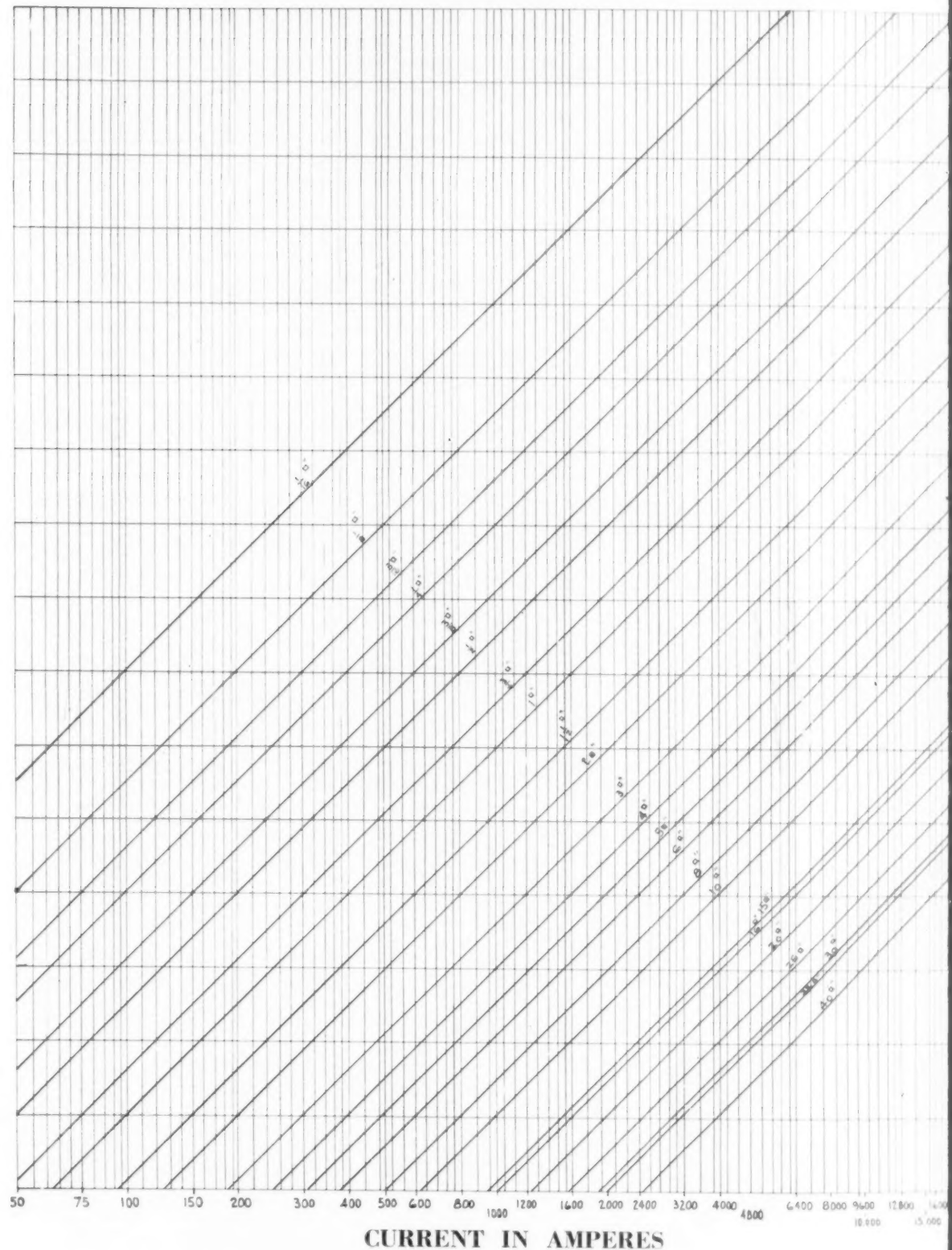
One of the important, but often neglected, factors in the design and layout of electroplating plants is the calculation of the voltage available at the plating tank. All too often it is taken for granted that the current produced by the generator or rectifier arrives at the tank at full generator potential. This, however, is not the case. Losses occur in the travel of the current from the generator through the bus bars leading to the tanks and these losses increase with the length of the bus bars, even though the most highly conductive materials commercially available may be used.

The chart* may be used as a source of quick and accurate information on the drop in voltage through copper bus bars. The lines sloping upward from left to right at the left side of the chart represent bus bars of various cross sections. The bottom of the chart on the left side shows the total current flowing, in amperes. The lines sloping upward from left to right, at the right side of the chart, represent the total length of bus bar through which the current passes. In a single-tank installation this would be the distance in feet from the generator to the tank and back again. The bottom of the chart on the right side represents the drop in potential in volts.

To illustrate the method of arriving at the loss in voltage, take, for example, 1000 amperes flowing through a bus bar of 1 square inch cross section for a total length of 25 feet. Read upward from the 1000 figure at the lower left hand side of the chart, until that line crosses the sloping line marked "1 square inch." Then, at this intersection move to the right, on a horizontal line, until that line crosses the sloping line marked "25 feet." From this point of intersection move vertically downward to the figures at the bottom of the right hand side of the chart to read the voltage drop. In this case it will be found to be 0.200 volts.

The same procedure can be used for any amperage, bus bar cross section and distance in feet of bus bar, shown on the chart.

This chart makes no correction for temperature or joints, but the effects of temperature rise are negligible and well proportioned joints may actually be lower in resistance than an equivalent length of bus bar.



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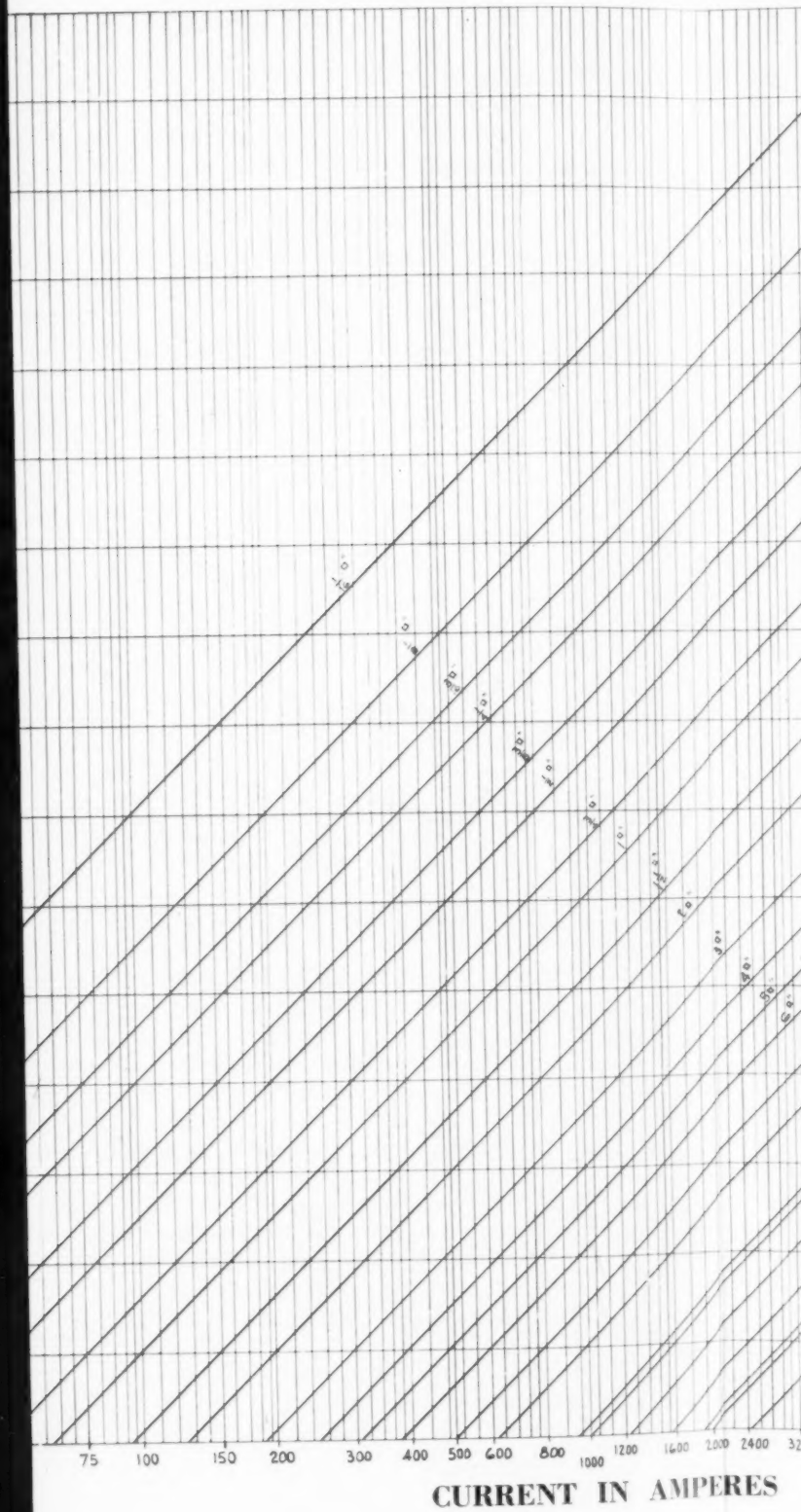
Chart for Calculating
Voltage Loss in Electroplating Bus Bars

(Material—Hard Drawn Copper—Conductor)

METAL FINISHING

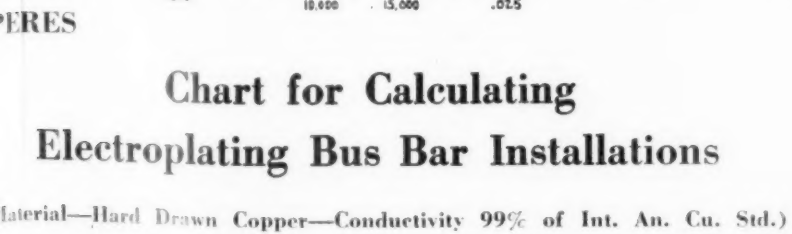
Large Loss In Electroplating

CROSS SECTION OF BUS BAR IN SQUARE



Elec

(Material—1

TOTAL LENGTH OF BUS BAR

METAL FINISHING, April, 1941

The Measurement of Metallic Brightness[†]

BY DR. RICHARD SPRINGER

Laboratory, Langbein-Pfahhauser Works, Inc.,
Leipzig, Germany

I. Introduction

WHEREAS apparatus of highest precision and versatility have been developed for the measurement of almost all of the technically important characteristics of metals, no generally accepted method has been available until now for the measurement of metallic brightness.

The uncertainty in the field of measurement of metallic brightness is due to the fact that there exists considerable diversity of opinion concerning the nature of brightness.

II. Brightness and Specular Reflectivity

It seemed natural to consider brightness as simply equal to total reflectivity, viz. physical mirror (specular) reflectivity, and to measure brightness by determining the total or specular reflectivity. It soon became obvious, however, that neither the measurement of total reflectivity at various wave-lengths, nor that of specular reflectivity are in themselves sufficient to define that quality which impresses the human eye as brightness.

By means of suitably polished sheets of nickel and silver, it is easy to demonstrate that higher intensities of specularly reflected light do not, in every case, correspond to a sensation of higher brightness, i.e., the relation between the psycho-physical value: brightness, to the physico-optical value: specular reflectivity, is neither simple nor definite.

In order to keep these conceptions clearly separate, it seems advisable to apply the word "brightness," according to its primary usage, solely for the definition of the psycho-physical sensation, and to define physical brightness as mirror or specular reflectivity. A practical example may serve to illustrate the difference: the quality of a polish is determined by its brightness, and that of a reflector-mirror by its specular reflectivity.

Accordingly, brightness is a psycho-physical quality which is only partly determined by specular reflectivity; so, until now, all efforts to define brightness by measuring specular reflectivity, were bound to fail. Judging this situation correctly, B. Egeberg and N. E. Promisel in their studies of measurement of brightness of electrodeposits, formulated the following postulate: "The final criterion of the success of any method in evaluating this brightness must be its ability to arrange a given series of specimens of different brightness in the same order as one would visually and with approximately the same spacing between samples. It must, in other words, regardless of derivation, satisfy the psycho-logical factors present¹."

1. B. Egeberg and N. E. Promisel, First International Electrodeposition Conference, March 3rd and 4th (1937).

III. Aim and Importance of the Measurement of Metallic Brightness

The question arises, whether there is any practical importance in the determination of this psycho-physical quality. In fact it has many applications:

- (a) To standardize metal surfaces.
- (b) To study and to control bright electroplating solutions, for instance the quantitative definition of the degree of effectiveness of a bright nickel bath and the quantitative determination of its decrease in brightness.
- (c) To state the required brightness or the limit of its acceptability in commercial orders in the metal industry.
- (d) To define the required polish of the base metal in bright electroplating.
- (e) To study the problems of tarnishing, viz.: dulling of metallic surfaces under certain atmospheric conditions.
- (f) To measure the effect of bright and matte dips, etc., on metal surfaces.
- (g) To measure quantitatively the polishing action of polishing compounds in comparative experiments, etc.

IV. Former Experiments in Measuring Brightness of Metals

Besides Hardy², Hunter³, Jacquet⁴ and Kenworthy⁵, the two American research workers, Egeberg and Promisel (loc. cit.), studied this problem most elaborately. They define brightness as the degree of deviation of *metallic* specular reflectivity from true specular reflectivity, caused by a partially diffuse reflection.

At first, they tried to determine specular reflectivity, as completely as possible, by elaborate measurements based on the assumption that the more light is specularly reflected, the less can be deflected diffusely. They found that, by measuring the specularly reflected light, considerable differences in brightness can be easily determined and coordinated with the visual findings. In case, however, the differences of brightness were only slight, the photometric values found differed from the visual findings, even with silver, which, as is known, reflects uniformly in the total range of light waves. For this reason, the method proved of little use. Accordingly, by determining specular reflec-

[†]Translated by Dr. Walter R. Meyer from "Zeitschrift für Elektrochemie," 46, 3-13 (1940).

2. A. C. Hardy, Jour. Optical Soc. Amer. and Rev. Science Instrum., 18, 96 (1929).

3. R. S. Hunter, Bur. of Stand. J. of Res., 16, 359 (1936).

4. P. A. Jacquet, Trans. Electrochem. Soc., 69, 25 (1936).

5. L. Kenworthy and J. M. Wahlram, Jour. Inst. Metals 55, 247 (1934).

R. S. Hunter, A new Gloss Comparator (and bibliography), Scient. Method Section of Nat. Paint and Varnish Assoc., Washington, D. C. (1935), Circular No. 493.

tivity only, measurement of brightness is not possible.

After this failure, the authors tried to establish a method based on the measurement of the diffusely reflected light. By means of angle-photometers, suitably applied, the diffusely reflected light was measured in one plane under varying angles. For this purpose, photoelectric cells, photographic methods, and the Mabeth-Illuminometer were used. The determined values of samples of varying brightness were condensed on curves. The structure of these curves represents a measure of brightness. The fact that the measurements taken with six samples of silver of varying brightness were in accordance with the visual impression, was taken as proof of the usefulness of this method.

In order to define the reflectivity curve and thereby brightness by only one single figure, a formula was developed, making it possible to calculate this brightness value from the measured values of specular reflection and the diffuse reflection, under given angles. The authors believe that it is not sufficient to measure diffuse reflectivity under one angle only, but that it is necessary to determine the entire curve of reflectivity. Using this method, it is possible to define the brightness of all metals, since it takes into account the relative values only, of the diffuse and spectral reflections.

The diffuse reflection of highly polished samples could not be determined by means of the apparatus mentioned and this circumstance led to the conclusion that the diffuse reflection of highly polished specimens might be neglected. The following is to prove that by means of suitable apparatus, it is possible to measure the reflectivity of highly polished parts and to determine even very slight differences in brightness.

V. New Experiments for Measurement of Metallic Brightness

In the light of the preceding discussions, the first task in testing methods of measuring brightness is to ascertain how well the numerical findings correspond to visual judgment. Before proceeding, however, to the description of our method, may we insert a partly repetitious discussion of the nature of brightness: Whoever evaluates brightness of metallic objects practically, will have to acknowledge that it is not the specularly reflected light, but rather the diffusely reflected light that creates the impression of brightness. To be exact, brightness to the human eye is but the lack of dullness. The impression of matteness is caused by diffuse reflection of light; the less there is of this impression, that is, the less diffuse light is reflected by a metallic object, the brighter the latter appears to be. This consideration necessarily leads to the conclusion, empirically arrived at by Egeberg and Promisel, that in order to determine the psycho-physical effect of brightness, it is more nearly correct to measure the diffusely reflected light rather than the specularly reflected light.

Based on this understanding, the first step is to find a simple and reliable method for the measurement of diffuse light.

(a) An Apparatus for the Measurement of Diffuse Light

For this purpose, the Pulfrich photometer, made by Zeiss, was found to be particularly useful, an instrument that is being practically applied to the measurement of lustre of

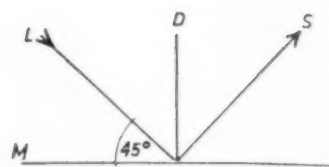


Fig. 1 Drawing illustrating how light, at an incident angle of 45° , is reflected from a flat, bright metal surface.

textiles, etc., although on a different basis. The drawing (Fig. 1) illustrates how the instrument works. If parallel light "L" falls on a flat, bright metal surface at an incident angle of 45° , it is specularly reflected at the same angle for the most part and only a small percentage "D" is reflected diffusely. By comparing this diffusely reflected portion of light with a block of magnesium carbonate of pure white color according to the principle of the Pulfrich photometer, the percentage of light, diffusely reflected by the bright surface can be measured. Preliminary experiments proved that with such measurements, a series arrangement may be obtained which satisfies the postulate by Egeberg and Promisel, namely, that in a given series of specimens of different brightness the specimens should be arranged in the same order by the apparatus as by the eye. These measurements, therefore, correctly determine the character of metallic brightness, although the diffusely reflected light is measured only at the 45° angle. At the same time, these preliminary experiments proved that this particular angle of 45° must be of special significance. After all, when judging brightness visually, the object to be examined is inspected, as a rule, from above, that is vertically, or nearly so, relative to the object, with laterally incident light.

(b) Description of the Pulfrich Photometer

The Pulfrich photometer (Fig. 2) consists, in principle, of two parallel telescopes with one common eye-piece. Behind the latter there is a device permitting the insertion of color-filters into the path of light. The range of vision is divided into two semi-circular areas by means of a vertical line. Each semi-circular area corresponds to an aperture of the photometer. The adjustment device consists of two equal measuring drums, attached at the openings of the photometer. By rotating the drums, luminosity in each of the semi-circular areas can be measurably altered. The graduation on the drums is constructed in such a manner as to permit the percentage accuracy to be approximately equal in the various ranges of measurement. Accordingly, with the Pulfrich photometer, the human eye serves as the zero



Fig. 2. Drawing of Pulfrich photometer.

point instrument. The light strikes the sample to be examined and the block of magnesium carbonate, both placed beneath the two objectives, at an angle of 45°.

(c) *Directions for Conducting Measurements of Brightness of Metals and Electrodeposits by Means of the Pulfrich Photometer*

The following procedure proved to be most reliable in the course of the measurements:

1. The red color filter (L 1) is to be used in all measurements of metallic brightness.

2. (a) The sample is placed on the left sector of the circular stage and the left drum is turned to point 100.0. The sample has to be cut so as to fit exactly into the sector of the circular stage.

(b) The white measuring block is placed to the right into the lighted circle; the right hand drum is used to adjust the light to the point of equal intensity.

(c) The lighted oval areas should be equally large on either side; it is best to choose them of such size that the white field appears just lighted.

(d) The object filters (platinum gray filters) are always placed to the right above the white block. They serve the purpose of increasing the accuracy of measurement of small and minute values of reflectivity.

3. A few measurements are made with samples of varying brightness, then, after having interchanged the circular stage and the measuring block, the same samples are measured again, in order to check the apparatus as to the equality of both its sides. In case the two sides of the apparatus are found to be unequal, the values measured have to be multiplied by a correcting factor to be previously determined.

4. (a) Values above 16% are measured without the use of the objective filters.

(b) Values ranging between 8 and 16% are taken using the 8% filter, turning the left hand drum to point 50. The measured value has to be multiplied by two.

(c) Values between 1.4 and 8% are measured with the 8% filter.

(d) Values between 0.7 and 1.4% are measured with the 0.7% filter, turning the left hand drum to point 50 and multiplying the value found by two.

(e) Values up to 0.7% are measured with the 0.7% filter.

5. The sample to be tested is rotated 360° by means of the circular stage in the lighted circle and the maximum, "Q," and minimum, "L," values measured.

6. The measurements should always be conducted in two or three stages:

(a) After fixing the point of approximate equality, the observation should be interrupted, in order to rest the eye (best, by looking on a green background).

(b) By looking into the apparatus again, it is determined whether the left area is lighter or darker than the right; in case the left area appears lighter, the right hand drum is turned slightly to the right; if it is darker, however, the right hand drum is rotated to the left.

(c) Then the drum is rotated very slightly both ways until the point of equal intensity is reached.

(d) If necessary, the observer looks away again for one minute and then re-examines the correctness of adjustment.

7. As brightness may possibly decrease with time, due

to tarnishing, every measurement should be dated.

8. Spotty sheets are to be breathed on and then wiped with a cloth.

9. In case the measured value is above 100, the left drum above the sample should be turned to 50 or 25, respectively, and the value found to be multiplied by 2 or 4, accordingly. Values above 100 are found whenever due to a particular structure of the scratch lines (e.g. by scratching with powdered pumice), some of the specularly reflected light also enters the object glass.

10. If possible, no measurements should be made in the ranges between 60 and 100% without the use of filters, because too high an intensity tires the eye. When measuring in this range, the left drum above the sample is to be set at 50 and then the measurement taken in the range between 30 and 50. The value found is to be multiplied by two.

11. The accuracy of the measurement amounts to approximately 10% of the numerically determined values, which is sufficient for all purposes.

12. Practical observations have shown that longitudinal values are estimated by the eye as follows: 0.00 up to 2%, high brightness; 2 up to 8%, semi-brightness; 8 up to 13.5%, matte with a faint gloss; 13.5 up to 50%, matte.

(d) *Experimental*

In order to examine the applicability of the Pulfrich photometer for measurement of metallic brightness by testing it on an extensive basis, 74 various metals of different treatment and varying brightness were measured. The results are summarized in Table I.

The following may be noted concerning the table:

1. The measurements were conducted using the red filter "L 1" because the latter was found to permit the highest degree of similarity of tone of color of the two semi-areas to be compared, with all metals tested.

2. As was to be expected, varying results were obtained, depending on whether the polishing lines on the specimen were parallel or vertical to the course of the light. In the latter case, the polishing grooves, often hardly visible to the naked eye, refract the light and reflect it partially upwards. For this reason, two values were taken with every sample; the longitudinal value "L" (polishing stroke parallel to the incident light), and the transverse value "Q" (polishing stroke vertical to the incident light). The direction of the polishing stroke cannot always be determined with certainty, especially on highly polished parts. The semi-areas in the ocular glass are inspected while the circular stage is turned slowly, and the minimum "L" and maximum "Q" values are noted.

The difference between the longitudinal and the transverse values may be seen even with the naked eye. The influence of the polishing stroke on the impression of brightness indicated by the longitudinal "L" and the transverse "Q" values found can be seen even with the naked eye very distinctly by placing the two pieces of zinc sheet near the window in such a way, that the polishing stroke on one of them is parallel to the window frame while, on the other, vertical to it. The sample, on which the polishing stroke is parallel to the window frame, appears to be more matte.

3. Measurements were made by three observers and the three results found were averaged.

4. In order to conduct the experiments on the broadest

TABLE I

Number of Specimen	Detailed Description of Samples Tested	EXPERIMENTAL DATA							
		B. I ¹		B. II ²		B. III ³		Average	
		L	Q	L	Q	L	Q	L	Q
1.	Copper sheet, untreated	9.0	45	9.3	49	9.3	51	9.2	48.3
2.	Copper sheet, scratched with powdered pumice by hand	12	75	16	74	18.2	75	15.3	74.6
3.	Copper sheet, scratched with pumice on brush	8.0	45	8.6	39	9.4	45	8.7	43.0
4.	Copper sheet, lightly polished	1.3	100	1.2	104	1.4	109	1.3	104
5.	Copper sheet, brought to high polish	1.0	52	1.0	50	1.1	54	1.0	52
6.	Copper deposit on iron out of a matte potassium cyanide bath	37	55	40	56	43	61	40	57
7.	Brass sheet, untreated	7.5	23	7.8	24	8.0	25	7.8	24
8.	Brass sheet, scratched with powdered pumice by hand	5.8	30	5.4	36	5.9	29.5	5.7	31.8
9.	Brass sheet, scratched with powdered pumice on brush	3.3	45	3.7	42	3.7	45	3.6	44
10.	Brass sheet, lightly polished	0.26	72	0.3	70	0.3	74	0.3	72
11.	Brass sheet, brought to a high polish	0.18	63	0.2	54	0.25	60	0.2	62.3
12.	Brass sheet, commercially polished	0.99	48	0.85	50	0.8	47	0.9	48
13.	Brass deposit on pumiced iron, at 0.3 amp./dm ² , 30° C.	7.5	190	6.9	184	6.9	192	7.1	189
14.	Brass deposit on pumiced iron, at 0.9 amp./dm ² , 20° C.	8	250	9.0	222	8.4	225	8.4	232
15.	Nickel deposit on crude copper sheet, untreated	26	32	26	31.0	27.5	32.8	26.5	32
16.	Nickel deposit on crude copper sheet, scratched with powdered pumice on brush	1.8	65	2.1	70	1.9	74	1.9	70
17.	Nickel deposit on crude copper sheet, polished	0.37	26	0.4	25.0	0.4	27	0.4	26
18.	Nickel deposit on crude copper sheet, polished	0.5	17	0.5	18	0.5	20	0.5	18.3
19.	Bright nickel deposit on crude copper sheet, untreated	1.8	4.1	1.9	4.0	2.0	4.5	1.9	4.2
20.	Bright nickel deposit on crude copper sheet, polished	0.22	5.2	0.2	4.5	0.2	4.6	0.2	4.8
21.	Nickel deposit on polished copper sheet, untreated	17	25	18	26.0	19.2	26	18	25.7
22.	Nickel deposit on polished copper, scratched with powdered pumice on brush	1.4	116	1.4	120	1.6	124	1.5	120
23.	Nickel deposit on polished copper, lightly polished	0.06	11.5	0.05	10.4	0.06	10.6	0.06	10.8
24.	Nickel deposit on polished copper, only buffed	0.06	17	0.06	18	0.07	14.8	0.06	16.6
25.	Bright nickel deposit on polished copper, untreated	0.42	3.0	0.4	2.9	0.4	3.2	0.4	3.0
26.	Bright nickel deposit on polished copper, buffed	0.16	3.8	0.13	3.7	0.14	3.64	0.14	3.7
27.	Nickel deposit out of a normal nickel bath, untreated, 1 amp./dm ² , 30 min.	7.5	12	7.2	13.4	7.8	13.1	7.5	12.8
28.	Nickel deposit out of highly effective bath, untreated, 1 amp./dm ² , 30 min.	5.6	7.8	6.1	8.3	5.8	8.6	5.8	8.2
29.	Nickel deposit out of highly effective bath, untreated, 0.75 amp./dm ² one hour	9.5	12	10.1	13.1	10.4	12.5	10.0	12.5
30.	Bright nickel deposit, untreated	0.64	6.9	0.5	7.4	0.6	7.8	0.58	7.4
31.	Bright nickel deposit, untreated	0.96	2.7	0.92	2.5	1.0	2.7	0.96	2.6
32.	Bright nickel deposit, untreated	0.5	4.3	0.6	4.2	0.5	4.4	0.5	4.3
33.	Bright nickel deposit, untreated	0.1	11	0.1	10.7	0.093	10.4	0.1	10.7
34.	Bright nickel deposit, untreated	0.14	6.1	0.15	6.3	0.14	6.65	0.14	6.4
35.	Usual nickel deposit, untreated	7.7	11.5	7.7	10.1	7.8	10.8	7.7	10.8
36.	Bright nickel deposit, polished	0.07	3.9	0.07	3.8	0.07	3.9	0.07	3.9
37.	Nickel deposit out of a citric acid bath, untreated	0.8	5.6	0.7	5.6	0.7	5.3	0.7	5.5
38.	Nickel deposit, polished	0.06	3.0	0.07	3.4	0.06	3.2	0.06	3.2
39.	Bright nickel deposit on crude copper sheet, unpolished, lacquered	2.3	7.5	2.4	6.9	2.1	7.8	2.3	7.4
40.	Bright nickel deposit on crude copper sheet, polished and lacquered	0.9	8.5	0.85	7.5	0.9	8.0	0.9	8.0
41.	Bright nickel deposit on polished copper sheet not buffed, lacquered	1.2	3.7	1.1	3.7	1.3	4.3	1.2	3.9
42.	Bright nickel deposit on polished copper sheet, buffed and lacquered	1.0	7.2	1.1	7.8	1.0	9.9	1.0	8.3
43.	Nickel-chromium deposit on crude copper sheet, Ni and Cr not polished	21	21	19.5	19.5	21.5	21.5	20.7	20.7
44.	Nickel-chromium deposit on crude copper sheet, nickel deposit scratched with powdered pumice on brush	3.5	74	3.6	70.0	3.5	74	3.5	73
45.	Nickel-chromium deposit on crude copper sheet (nickel lightly polished)	0.94	12.5	1.0	12.0	0.88	13	0.94	12.5
46.	Nickel-chromium deposit on crude copper sheet, nickel highly polished	0.19	31	0.2	34	0.17	34.5	0.19	33.2
47.	Nickel-chromium deposit on polished copper sheet, nickel unpolished	6.4	7.0	6.7	7.2	6.7	7.7	6.6	7.3
48.	Nickel-chromium deposit on polished copper, nickel scratched with powdered pumice on brush	2.1	180	2.4	160	2.1	162	2.2	167
49.	Nickel-chromium deposit on polished copper, nickel polished	0.23	29	0.24	34	0.24	32	0.24	31.7
50.	Nickel-chromium deposit on polished copper, nickel highly polished	0.18	46	0.2	44	0.19	44.5	0.19	44.8
51.	Nickel-chromium deposit on highly polished brass, chromium highly polished	0.09	3.0	0.084	3.2	0.08	2.8	0.084	3.0
52.	Nickel-chromium deposit on highly polished brass	0.06	3.2	0.06	2.9	0.06	3.3	0.06	3.2
53.	Chromium deposit on polished brass	1.02	24	0.8	25.0	0.9	26.5	0.9	25.2
54.	Chromium deposit on polished brass	0.44	21	0.5	22	0.50	21	0.5	21.3
55.	Chromium deposit on polished brass	0.42	34	0.4	36	0.35	37	0.4	36
56.	Chromium deposit on polished brass	0.65	10.6	0.6	10.4	0.62	11.5	0.62	10.8
57.	Chromium deposit on polished brass	0.47	16	0.4	17.0	0.4	18	0.4	17.0
58.	Silver deposit, directly out of bath	49	72	45.0	63.0	54	74	49	70
59.	Silver deposit, lightly polished	1.02	100	1.0	96	1.04	108	1.0	101

1. Author 2. Werner Franke 3. Karl Flemming

TABLE I (Continued)

Number of Specimen	Detailed Description of Samples Tested	EXPERIMENTAL DATA							
		B. I ¹		B. II ²		B. III ³		Average	
		L	Q	L	Q	L	Q	L	Q
60.	Silver deposit, highly polished	1.13	55	1.05	60.0	1.18	67	1.12	60.7
61.	Bright zinc deposit, untreated	1.9	6.4	2.2	8.0	2.2	7.9	2.1	7.3
62.	Bright zinc deposit, lightly polished	0.29	107	0.2	124	0.25	108	0.25	113
63.	Bright zinc deposit, highly polished	0.23	52	0.27	52.0	0.25	58	0.25	54
64.	Bright zinc deposit, slightly polished	0.60	42	0.55	44	0.57	44	0.6	43.3
65.	Bright zinc deposit, unpolished	1.7	6.6	1.9	7.0	2.0	6.4	1.9	6.7
66.	Bright cadmium deposit, unpolished	0.7	60	0.8	64	0.7	56	0.7	60
67.	Bright cadmium deposit, polished	0.7	100	0.7	108	0.8	102	0.7	103
68.	Bright cadmium deposit, highly polished	0.9	90	0.8	90	0.96	90	0.9	90
69.	Bright cadmium deposit, out of different bath	2.2	8.0	2.4	7.0	2.6	7.8	2.4	7.6
70.	Bright cadmium deposit, polished	1.2	53	1.3	60	1.09	60	1.2	57.6
71.	Tin deposit, untreated	47	47	44	44	48	48	46.3	46.3
72.	Tin deposit, scratched on circular scratch brush	2.9	52	3.0	57	3.2	57	3.0	55.3
73.	Tin deposit, highly polished	0.9	26	0.85	28	0.8	28	0.85	27.3
74.	Tin deposit, matte, out of alkaline bath, 1 amp./dm ² , 20 min., untreated	25	37	26	40	23	36	24.7	37.7

scale possible, the selection of samples was made so as to cover all metals important for the electroplating industry as well as the usual methods of preliminary and subsequent treatments of their surfaces.

A.S.T.M. MEETING IN WASHINGTON, D. C. (Concluded from page 192)

sults of extensive cooperative tests which have been carried out in five different laboratories. Some anomalous results were reported in parts of this testing program, but if these can be satisfactorily explained it will be possible to announce a standardized procedure for total immersion testing which will give concordant results in various laboratories.

Subcommittee III on Spray Testing considered the present Tentative Method of Salt Spray Testing of Non-Ferrous Metals (B 117-39 T) and is proposing a slight modification. The future program of work of this subcommittee includes the development of specifications for large spray chambers and for calibration of spray chambers.

Subcommittee VI on Atmospheric Corrosion presented a report containing a statistical analysis of the very voluminous one-, three-, and six-year exposure data on 22 different metals exposed at nine different locations. This information will be included in the annual report of the committee to be presented to the Society in Chicago in June.

A new subcommittee is being organized to be known as Subcommittee V on Statistical Analysis and Planning of Corrosion Testing. This subcommittee will act as adviser to the other subcommittees in the planning of their programs and in the analysis of the data resulting from that program.

Another new subcommittee is being organized to be known as Subcommittee VII on Weather. This group will attempt to collect the pertinent data in connection with weather at the various locations where exposure tests are now being conducted. In this case the term "weather" includes such things as sulfur dioxide, soot, dew, sunlight, wind velocity, temperature fluctuation, etc. If, as, and when data of this kind with respect to specific test locations can be correlated with the results of exposure tests at these locations, the subcommittee may undertake the collection of similar data with respect to other locations.

Officers of Committee B-3:

Chairman: Sam Tour, Vice-President, in charge of Chemical and Metallurgical Engineering, Lucius Pitkin, Inc., New York.

Secretary: A. W. Tracy, Assistant Metallurgist, The American Brass Co., Waterbury, Conn.

A.S.T.M. DIE CASTING COMMITTEE PLANS FURTHER EXPOSURE TESTS AND PER- FECTS STANDARD SPECIFICATIONS

A.S.T.M. Committee B-6 on Die-Cast Metals and Alloys, which has

had great influence in the development and use of various die castings through its extensive research work and in the development of standard specifications for various alloys, considered at its dinner meeting in Washington, D. C., during A.S.T.M. Committee Week, methods of financing an extension of atmospheric exposure tests on zinc, aluminum, and magnesium alloy test specimens. The committee's previous tests at various locations extending over some ten years need to be supplemented by information on new alloys, and a special committee has been appointed to solicit small contributions from a large number of producers and consumers of this type of casting. It is estimated that a sum of \$2,000 will defray the expenses required in erecting exposure racks, shipping charges, and related items. The committee in charge consists of: G. O. Hiers, chairman; W. M. Peirce, A. E. Keskulla, J. C. Fox, and C. R. Ince.

A committee consisting of J. R. Freeman, Jr., chairman; J. C. Fox, and Sam Tour was appointed to investigate and report to Committee B-6 at its next meeting whether there was sufficient interest in brass die castings to warrant the formation of a new subcommittee.

This subject, when discussed at the Committee B-6 meeting, elicited few comments other than that there would be considerable interest in brass die casting if die steels with satisfactory life could be obtained. Since the search for suitable die steels has been attempted unsuccessfully, it seemed unlikely that brass die castings would increase greatly in commercial importance in the near future. However, there may be a need for specifications for the parts now being produced as brass die castings and this phase of the problem is also to be considered by this committee.

The proposed changes in the composition of A.S.T.M. Zinc Base Alloy XXV (B 86-38 T) covering the raising of the minimum magnesium limit from 0.02 to 0.03 per cent and changing the maximum allowable tin limit from .002 to .005 per cent will be submitted for approval to the A.S.T.M. with the 1941 committee report.

Papers covering the up-to-date methods for the finishing of aluminum, zinc and magnesium alloy die castings are expected to be ready for presentation at the 1941 annual meeting. It is the hope of this committee that these papers can be published as appendices to their annual report.

Subject to approval by letter ballot, Subcommittee VII on Magnesium-Base Die Casting Alloys has prepared a specification for a new alloy to be known as No. 13X. This alloy is the same as Alloy No. 13 in the Standard Specification B94 except that the iron and nickel contents are held to low values (0.005 per cent maximum) in order to obtain maximum resistance to salt water corrosion. Mechanical properties are considered the same as for Alloy No. 13 which will run 29,000 to 34,000 psi. tensile strength; 2 to 5 per cent elongation in 2 in.; 1 to 3 ft.-lb. Charpy impact value.

Officers of Committee B-6:

Chairman: J. R. Townsend, Materials Standards Engineer, Bell Telephone Laboratories, Inc., New York.

Secretary: G. L. Werley, The New Jersey Zinc Co., Palmerton, Pa.

Fundamentals of Science Relating to Electroplating

Chapter VIII. Hydrolysis, Displacement and Electromotive Series

Now it may be recalled that hydrocyanic acid is a weak acid and ionizes only to a small extent (less than 1 per cent) so that, instead of cyanide ions (CN)⁻ and hydrogen ions (H⁺) existing freely together in solution, they combine until 99+ % of the cyanide ions have disappeared as such. This disappearance by combination takes with it, of course, a corresponding number of hydrogen ions which come from the water. In turn, the disappearance of hydrogen ions leaves in solution quite a number of its partner ions from the water, the hydroxyl (OH)⁻ ions. In effect then, there are left in solution mainly sodium ions (Na⁺) and hydroxyl ions (OH)⁻. Since sodium hydroxide is a strong base and ionizes 100%, there is no tendency for the hydroxyl (OH)⁻ ions to disappear from solution. The solution therefore reacts alkaline due to this excess of alkaline ions.

A simpler, though less scientific, way of understanding hydrolysis is merely this: The solution has in it the makings of sodium hydroxide (NaOH) and hydrocyanic acid (HCN). Since sodium hydroxide is a stronger base than hydrocyanic acid is an acid, the effect of the base predominates, and the solution is alkaline in reaction.

As a *general rule*, therefore, if a salt is a combination of a weak acid and a strong base, it will act like a weak base when dissolved in water. If a salt is a combination of a weak base and a strong acid, it will act like a weak acid when dissolved in water. Increased temperature and greater dilution will increase the effects of hydrolysis.

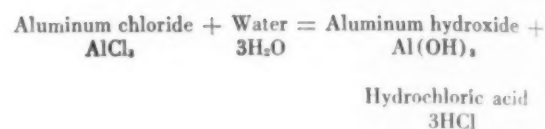
Some common salts which show effects of hydrolysis are given in Table VI.

Table VI—Hydrolysis of Some Salts

Salt	Formula	Solution acts
Trisodium phosphate	Na ₃ PO ₄ ·12H ₂ O	Alkaline
Borax	Na ₂ B ₄ O ₇ ·10H ₂ O	"
Sodium carbonate	Na ₂ CO ₃	"
Sodium cyanide	NaCN	"
Sodium sulfide	Na ₂ S	"
Ammonium chloride	NH ₄ Cl	Acid
Sulfates, chlorides and nitrates of the plated metals.	Examples: NiSO ₄ , CuSO ₄ , ZnCl ₂ , SnCl ₄ , FeCl ₃ , Cd(NO ₃) ₂	"
Soap	Examples: Sodium oleate and sodium stearate	Alkaline

When weakly alkaline or weakly acid solutions are needed, it is sometimes advisable to use solutions of the above salts rather than dilute solutions of strong bases or acids, since the action of the former is more stable. In Table VI it should be noted particularly that soap, being formed by neutralizing a weak fatty acid like stearic acid with a strong alkali like caustic soda still gives an alkaline reaction when dissolved in water. There really is, therefore, no such thing as a "neutral soap." The expression can at most mean that no excess caustic was used in, or left after, the manufacture of the soap. Naturally, the pH of a soap solution can be changed, however, by either adding more caustic or by adding mildly acidic materials such as more stearic acid, which in some metal washing operations may be advisable.

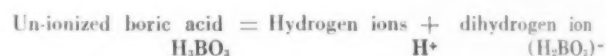
Another important illustration of hydrolysis is in the case of aluminum chloride. In degreasing with trichlorethylene, some decomposition of the solvent may take place if proper operating conditions are not observed. One product of decomposition is hydrochloric acid. If aluminum is present (as in degreasing aluminum alloys), especially as dust, the hydrochloric acid acting on it forms aluminum chloride. This particular compound acts as a catalyst increasing the speed of the break-down of the solvent. If a little water is present, however, the aluminum chloride hydrolyzes as follows:



The catalytic and accelerating action is thus prevented. (At the same time, however, trichlorethylene itself hydrolyzes when water is present.)

Many substances subject to hydrolysis are used as *buffering agents*. A buffering agent is one that helps merely by its presence in solution to keep the pH of the solution from changing, even though small amounts of acid or alkali may be added. Their function in electroplating baths is well recognized, as every plater realizes the difficulty of operating a nickel solution that does not contain sufficient boric acid. The boric acid in the nickel plating solution acts only as the buffering agent.

Buffering comes about in this way. Let us take as an example, the boric acid mentioned above. Boric acid, we know, is a weak acid and ionizes to only a small extent, i.e., it forms relatively few hydrogen ions, so that in itself it hardly affects pH. The ionization reaction is:



However, in any particular solution, the concentration of the hydrogen ions that are present is always a certain percentage of the concentration of the un-ionized boric acid. (See the discussion of "Equilibrium" in a previous chapter). If, therefore, another acid is added, furnishing other hydrogen ions, some of the hydrogen ions in the solution must disappear (forming un-ionized boric acid) to maintain this fixed percentage. On the other hand, if alkali is added, thus removing by neutralization some of the existing hydrogen ions, more hydrogen ions are formed by ionization of the boric acid to again maintain the fixed percentage. Thus the boric acid, by supplying or removing hydrogen ions as needed, acts as a stabilizer of the concentration of hydrogen ions, i.e., of the pH.

Buffering agents must be therefore either weak acids or alkalies or salts which can hydrolyze, as described above. For each range of pH, there are appropriate buffering agents.

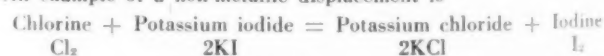
(6) Displacement

This type of reaction is particularly important in electroplating and may be the cause, for example, of such an apparently unrelated effect as peeling of the deposit. As the name indicates, it deals with the displacement by one element (usually metallic) of the corresponding element in a compound. Thus metallic iron in a copper sulfate solution displaces the copper, forming iron sulfate and metallic copper. The reaction is



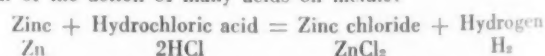
Incidentally, this might also be considered oxidation and reduction, since the valence of iron goes from 0 to +2 and the valence of copper from +2 to 0.

An example of a non-metallic displacement is



Since we are interested mainly in metals, the non-metallic displacement will not be further included in this discussion, which can however be applied in a general sense to the whole field.

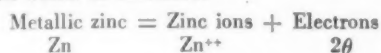
Still another example of displacement is the following, which is typical of the action of many acids on metals:



The question naturally arises: When will a metal (or in general

an element) displace another element? The answer to this question brings up the discussion of the electromotive series.

When a metal, such as zinc, is placed in a solution of its ions, such as a solution of zinc chloride, there is a certain tendency for the metallic zinc to form more zinc ions in solution. This tendency is called *solution pressure*. At the same time, there is a tendency for the metal ions in the solution to go to the solid metal form, which can be done by adding electrons to themselves (to neutralize their positive charges). The equation for metallic zinc dipping into a zinc chloride solution would be therefore:



The difference between these two tendencies (to go into solution and out of solution) is measured as a difference of electrical potential. If the ions may have more than one valence, there is a definite reaction and potential for each valence. Obviously, the greater the number of ions already in the solution, the less tendency there will be for the metal to form more ions, so that the potential difference not only varies from one metal to another, but for any one metal depends on the concentration of metal ions in the solution being considered. For comparison purposes, a "normal" solution is used. ("Normal" in this sense refers to a solution containing a concentration of metal ions, expressed in grams per liter, equal to the atomic weight of the metal divided by its valence.) Also, purely for convenience and for reference purposes, the normal potential of hydrogen is considered to be zero, so that the normal potentials of the metals really mean that much higher than hydrogen or that much lower than hydrogen. If the normal potentials of all the metals are arranged in order of their increasing (or decreasing) values, the very important *electromotive series* is obtained. This series, for the metals of greater interest to platers, is given in Table VII.

Table VII—Electromotive Series of Metals

(Single electrode potentials in volts of some metals, in solutions normal in their ions, referred to the Normal Hydrogen Electrode)

Potassium	−2.92
Sodium	−2.71
Magnesium	−2.4
Aluminum	−1.7
Manganese (Mn ⁺⁺)	−1.1 (?)
Zinc	−0.76
Chromium (Cr ⁺⁺⁺)	−0.5 (?)
Iron (Fe ⁺⁺)	−0.44
Cadmium	−0.40
Nickel (Ni ⁺⁺)	−0.22
Tin (Sn ⁺⁺)	−0.13
Lead (Pb ⁺⁺)	−0.12
Iron (Fe ⁺⁺⁺)	−0.04
Hydrogen	0.00
Antimony	0.1 (?)
Bismuth	0.2
Arsenic (As ⁺⁺⁺)	0.3 (?)
Copper (Cu ⁺⁺)	0.34
Copper (Cu ⁺)	0.52
Silver	0.80
Mercury (Hg ⁺⁺)	0.86
Gold (Au ⁺)	1.5 (?)

In Table VII, the more negative a value is, the greater is the tendency for that metal to go into solution. For this reason, any particular metal will displace from solution any other metal below it in the series. (We have finally, in other words, arrived at the answer to the question which started this whole discussion.) Thus, metallic iron, dipping into a "normal" copper solution, will spontaneously displace (i.e., precipitate) metallic copper. Copper, in turn, could displace metallic silver. Theoretically, silver would precipitate metallic gold from a "normal" solution of its ions. Zinc would displace hydrogen from a solution and since the hydrogen ions come from acids, this means zinc would dissolve in that acid. In general, all the elements above hydrogen tend to dissolve in acid solutions normal in hydrogen ions, liberating hydrogen gas. Those metals above hydrogen, which readily dissolve in acids, are called "active" or "base." Metals such as gold and silver, at the other end of the table, are called "noble."

As always, certain limiting conditions should be kept in mind. First of all, Table VII refers to solutions normal in ion concentration as defined above. If the solutions differ in concentration, as already mentioned, the numerical values will change. The order of

some of the metals can be reversed by proper manipulation of the solutions. (The application of this to electroplating solutions will be discussed under plating baths.) In the second place, the intensity of the tendency for displacement depends on the relative positions in the table. Thus zinc will more readily displace copper from a normal solution than iron because of the greater difference in its normal potential compared to copper. In the third place, clean and pure metal is implied. If the metal contains alloying agents or has become passive, the results may be different than indicated above. For this reason, chromium and nickel rarely act as indicated in the Table, and iron may be made to remain undissolved in concentrated nitric acid. Similarly, contrary to the indication in the Table, aluminum may displace nickel from solution less readily than zinc because of the presence of oxide films on its surface. However, once the films are effectively removed, the displacement reaction becomes as active as expected.

What applications can be made of this table, always bearing the above reservations in mind? Some illustrations are given in the Appendix which follows.

Appendix to Chapter VI

Some Practical Applications of the Electromotive Series.

The use of Table VII to determine what chemical reactions are possible,—what will precipitate what from solution, so to speak—has already been mentioned.

The figures also give a relative measure of the potential necessary to deposit the metal from solution. Thus gold tends to precipitate spontaneously from solution, its normal potential is so high. On the other hand, quite a high potential is needed in electrodeposition to overcome the high solution pressure of zinc in a solution normal in its ions. (More about this under Plating.)

Battery voltages may be computed by taking the algebraic difference of the metal potentials involved. Thus the old Daniell Cell or Gravity Cell, using copper and zinc dipping into solutions of their respective ions, would have a cell voltage of 0.34—(−0.76) or 1.10 volts if the solutions were normal in metal ions. (Actually they were usually of different strengths.)

In plating zinc with nickel, the zinc tends to precipitate the nickel on itself as soon as it is immersed into the solution (*Immersion Plating*). This nickel, deposited without the influence of current, is black and non-adherent and any electrodeposits built up on it therefore peel. By modifying the nickel solution (as by adding large amounts of sulfates or by forming complex ions) the nickel ion concentration can be reduced and therefore the tendency for the nickel to plate on zinc by immersion is diminished. This is the principle of nickel solutions designed for plating on zinc. While on the subject of immersion plating, it should be pointed out that once the immersed object is covered with even a very thin coating of the deposited metal, action theoretically ceases and no more metal is deposited, because it is now no longer, for example, zinc immersed in nickel but nickel immersed in nickel.

Recovery of precious metals is often effected by the principles stated above, as in the case of zinc being used to reclaim silver and gold from scrapped solutions.

Galvanized iron (or in general zinc coated iron) utilizes the principle of the sacrificial solution of the zinc to save the iron. Due to the difference in potentials, the zinc and the iron form a *couple*, that is, with moisture and carbon dioxide dissolved from air they form a miniature battery as described above, with zinc acting as an anode since it forms ions more easily than does iron. The zinc therefore dissolves instead of the iron. Furthermore, the zinc forms zinc carbonate which protects that particular spot from further attack. (Iron rust does not form such protective coatings which retard further rusting.) On the other hand, when tin is used as a coating, an iron-tin couple is formed and iron acts as an anode since it tends to form ions more easily than the tin. The iron therefore goes into solution, so that once the coating is gone, at any place, the iron corrodes even more rapidly, due to the "couple action," than if the tin were not there. Tin coatings should therefore be thick enough and pore-free to prevent attack from even starting. Still another illustration of "couple action" is in testing for local thickness of chromium on nickel, where the time is measured for the chromium at any desired spot to dissolve in hydrochloric acid. To avoid any lag or delay in starting to dissolve, the chromium is touched with a nickel wire. Nickel, being a more noble metal, forms a couple with the chromium in which the chromium acts as an anode, and thus accelerates the dissolving of the chromium.

Defective Cadmium Solution

We are sending you a sample of our cadmium solution which we would like to have analyzed. Will you tell us what it needs to bring it up to the proper strength.

A. Your cadmium solution has been tested, and the results are as follows:

Cadmium 2.0 ozs./gal.
Total sodium cyanide..... 3.2 " "
Free sodium cyanide trace

Normally, a cadmium solution is run with about 9 ozs./gal. of free sodium cyanide. To obtain this, you would have to add, therefore, 9 ozs. of sodium cyanide to each gallon of your solution. Such a large addition of cyanide can cause poor plating for a while, however. This is because during the low cyanide period many impurities (copper, lead, etc.) will have been precipitated to the bottom of the tank. When the fresh cyanide is added all at once, these impurities are all taken back into solution with resulting poor deposits being obtained.

Therefore it is suggested the first thing you do is to clean out the tank. Then add the required cyanide a few ozs./gal. at a time.

The metal content of 2 ozs./gal. would be considered on the low side. Normally about 3 ozs./gal. of metal is used. To obtain this, you would have to add 1.1 oz./gal. of cadmium oxide. To dissolve this amount of oxide you need about 1 3/4 ozs./gal. of sodium cyanide, in addition to the 9 ozs./gal. of sodium cyanide to bring up the free cyanide.

It is noted you have some sort of addition agent in this solution. Due to the wide variation in results obtained with addition agents, we are not in a position to say if the above recommendations would give perfect results under your conditions.

—G. B. H., Jr.

Faulty Silver Solutions

Q. We are sending you two samples of our silver plating solutions, No. 1 and No. 2. No. 2 solution has never worked properly and the deposits come out a trifle hard and with a glazed appearance. The anodes are rough and dark and on removing them at night, there is a smutty substance which drips or rinses off into the solution. Solution No. 1 has been used for the past ten years and up to recently has been working satisfactorily. The throwing power at present seems low; the deposit is soft; very sensitive to finger-marking, and the articles have had a yellow streaky discoloration. The anodes act similar to those in solution No. 2.

We have noticed particularly on flat surfaces that we will find little specks which streak for possibly a quarter of an inch.

Following your directions some time ago,

Technical Advisor For April Issue

G. B. HOGABOOM, JR.
Consultant in Electroplating
and Metal Finishing.
Newark, N. J.

we removed carbonate and the solution worked nicely for a while and then the trouble reappeared. Both solutions are now in rubber-lined steel tanks.

A. The solutions were tested for metal, and free cyanide and showed:

Solution No. 1

Free sodium cyanide 7.0 av. oz./gal
Silver 2.2 tr. "

Solution No. 2

Free sodium cyanide 8.6 av. oz./gal
Silver 2.4 tr. "

The metal contents are satisfactory, but for regular plating, a free cyanide of 3 or 4 oz./gal. of sodium cyanide would be sufficient.

A new solution should be made up with 3 oz. of sodium carbonate in addition to the silver and cyanide.

It is also better to use silver cyanide rather than the chloride as the latter does not give as smooth a deposit, or as good anode corrosion. Furthermore, silver solutions with a high chloride tend to produce a film of silver chloride on the deposit. This is light sensitive and will cause discoloration.

The No. 1 solution shows a high contamination with lead. This cannot be removed, and if a solution with best possible characteristics is desired, the best thing to do is to recover the metal from the old solution (plate it out), send to a refiner, and make up a new solution with:

Silver cyanide 2.5 oz./gal.
Potassium cyanide 5.2 "
Potassium carbonate 5 "

G. B. H., Jr.

Contaminated Gold Solution

Q. I have a 24-K gold plating solution that is contaminated with copper. Will you give me a practical method to separate the copper from the gold in order to use the gold to make up a new bath.

A. Before going to the expense or trouble of obtaining gold from your solution, it is

suggested you test the solution, or have it tested for the amount of gold it contains. If the amount of gold present is not worth over 2 or 3 dollars it does not pay to refine it.

C. M. Hoke, in the book "Refining Precious Metal Wastes" suggests the following method:

"Make the solution acid with hydrochloric acid, under well ventilated conditions so as not to breathe the very poisonous hydrocyanic fumes which are given off. Then add a solution of 1 part ferrous sulfate (copperas) to 2 parts water. Use about 7 oz. of copperas for each ounce of gold to be recovered. Allow mixture to stand overnight. Gold will precipitate as a fine powder.

Decant off supernatant liquid, add water, and allow gold powder to settle again. Repeat, to wash the gold powder free from contamination. Decant again, then cover powder with hydrochloric acid to dissolve out iron mud. Wash again. Remainder is gold powder which may be dissolved in aqua regia (1 part nitric acid, 3 parts hydrochloric acid). Evaporate this solution to a syrup (not to dryness), add water, and then precipitate gold fulminate by adding ammonia. Allow to settle, and wash by decantation. The fulminate is explosive when dry, so keep it wet. The gold fulminate may be used as is gold cyanide to make up a new gold plating solution."

Other methods can be used, but all are somewhat lengthy and therefore the best thing to do with solutions of small gold content is to allow them to evaporate to dryness, and save the solids. When enough is collected, send it to a refiner.

G. B. H., Jr.

Gold Plating Jewelry

Q. Will you please tell me the correct method for bright gold plating white metal jewelry?

A. It is desirable, before gold plating, to plate with a brass or a nickel plate, or a brass followed by a nicked flash. The latter is preferable.

For brass plating, use a formula such as given on page 29 of the 1940 Guidebook. Just apply a flash, as a heavy plate will become dull.

Gold can be plated directly over this brass flash, if desired. However, a gold deposit of a clear yellow color will be obtained if a nickel flash is applied over the brass plate, and then gold over the nickel.

For gold plating use:

Potassium gold cyanide 1/2 oz./gal.
Potassium cyanide 1/2 "
Temp. 160° F.; C. D. 1-5 amp./ft.²

G. B. H., Jr.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Stainless Steel Polishing Compounds

Hanson-Van Winkle-Munning Company, Matawan, N. J., have announced a complete line of rouges and other compounds used for polishing stainless steel. It is stated that an outstanding constituent of these polishing compounds is a special levigated alumina flour. Development work has been in progress for some time, and has, according to the manufacturer, resulted in the perfection of a variety of grades and numbers to produce all of the finishes required in the manufacture of metal products, from rough ground to mirror finishes. The manufacturers are ready to provide a suitable compound for any class of work desired.

Anti-Spot After Cyanide Plating

Special Chemicals Corp., 30 Irving Place, New York City, have developed a new material called "Anti-Spot" which is claimed to overcome difficulty from staining of copper and other metal plate deposited from cyanide solutions.

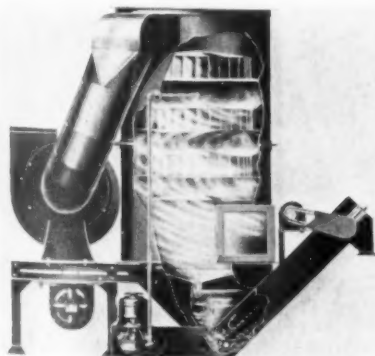
Frequently deposits obtained from cyanide solutions stain after standing about for from a few hours to a few weeks, depending upon humidity. This is due to the reaction between moisture in the air and alkalis trapped in the pores.

The new product is stated to effectively inhibit the attack of the alkali on the metal surface or upon the lacquer coating.

It is used in concentration of 4 oz. per gallon at room temperature. After plating and rinsing, the work is immersed in the "Anti-Spot" solution for approximately one minute; is then rinsed and finished.

Unit Type Dust and Fume Collector

The Claude B. Schneible Company, 3951 Lawrence Ave., Chicago, Ill., recently announced a new line of unit dust collectors



Unit type dust and fume collector.

in 2,000 to 10,000 c.f.m. capacities.

These new models, designated Type "U C", consist of a fan; five spray curtain tower; pump; settling chamber and sludge ejector-conveyor.

The collector tower is of conventional multiwash design employing water in a cyclonic wash action to absorb dust and fumes on impingement plates and vanes.

It is claimed that heavy particles are precipitated in the lower inlet cone of the collector, fines being collected and washed back into the sludge chamber by the downward moving water spray curtain.

The collector proper has no moving parts so has nothing to wear, clog, burn or break.

The sludge ejector-conveyor operating at slow speed removes sludge from the precipitation chamber, dewateres it in the conveyor boot and discharges it into any convenient receptacle.

The unit occupies a minimum of floor space and it is claimed is low in cost and requires a negligible amount of maintenance.

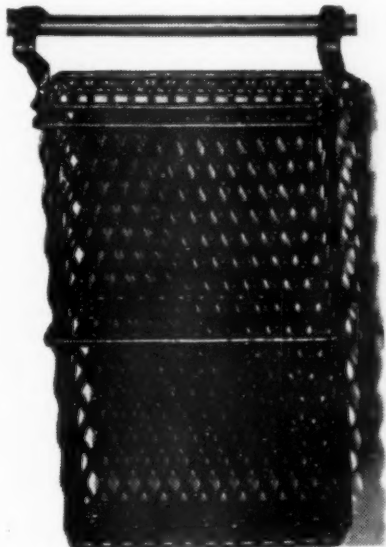
Bulletin 141, available from the maker, contains complete details.

Improved Scrap Anode Saver

Automotive Rubber Company, 8601 Epworth Boulevard, Detroit, Michigan, manufacturers of all types of rubber insulated equipment for the electroplating and pickling industries present the improved "Automotive Scrap Anode Saver" for use during the present emergency.

With defense priorities restricting the available supplies of non-ferrous metals obtainable for electroplating, the use of scrap is rapidly becoming a standard procedure.

To facilitate the use of this scrap metal,



Scrap anode saver.

which was formerly sold for re-smelting, Automotive Rubber Company has perfected their anode scrap saver, a reinforced expanded metal basket completely insulated with semi-hard rubber suitable for use in modern plating solutions.

In use, the anode scrap saver is hung on the anode rod at a point of high current flow, and several live anodes are used to carry current to the scrap which is piled in the basket around the good anodes. The importance of making ample and positive contact to the scrap pieces cannot be too strongly emphasized. Sufficient current must flow into the basket, since the active anode area is increased ten to fifteen times. Practice has found that the best way of obtaining this end, is to bolt anodes to the anode bar throughout the length of the basket.

Anode scrap savers have been used for years in conjunction with nickel plating, but recent restrictions have made it practical for use in acid copper plating solutions. In this process it is not necessary to use pure copper as the process itself serves as a method of electrolytic refining.

Many firms are now using fifty to one hundred and more of these baskets in their present plant operations, not only as a money saving device, but more so as a means of prolonging production.

Solution for Brightening Gold

Linick, Green & Reed, Inc., 29 E. Madison St., Chicago, Ill., are marketing a product called "No. 7 Alkaline Electro-strip" for brightening gold rings.

This material, according to the manufacturers, leaves a bright surface similar to that obtained by electropolishing, but no

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AGITATORS
TUMBLING BARRELS
OBLIQUE BARRELS
INSULATING JOINTS**



• Our new complete general catalog will be gladly sent free to buyers making the request on company letter-head.

Crown Rheostat & Supply Co.

1910 Maypole Avenue -- -- Chicago, Illinois

measurable amount of metal is removed as compared with cyanide solutions, which are excellent solvents for gold.

The strip contains no cyanide and is used either warm or hot, and the article is made the anode at from 6 to 10 volts. The cathodes may be copper, stainless steel or almost any other metal.

The material, as sold, is concentrated and can be diluted with as much as 6 parts of water to 1 part of stripping solution.

Corrosion Preventives

Potomac Chemical Co., Inc., 607 15th St., N. W., Washington, D. C., have announced a series of thin film rust preventive compounds called "Tectyl" products, for application to iron, steel, copper, magnesium and other metals to inhibit corrosion.

Polar molecules are utilized in the manufacture of the compounds and the orientation obtained with the polar compounds insures excellent adhesion of them to the base metal, and maximum protection with minimum film thickness.

The products consist of a stabilized lanolin base which is dissolved with a wetting agent, a dispersing agent and an inhibitor in a hydrocarbon solvent. When applied to metal surfaces, these compounds produce thin, adherent, protective films which are recorded to effectively isolate the metal from moisture. The films are transparent and any incipient corrosion is easily detected. The solubility of the film in common organic solvents permits it to be easily washed off when desired, but because of the thinness of the film, they frequently do not have to be removed. Thus, it is claimed, that the thin film will protect as good, or better than, heavy slush layers of grease.

The materials can be applied by spraying, brushing, dipping or flushing. Effective life of the film is said, in some cases, to be as great as two years when exposed to outdoor weathering.

Four separate products are available. Tectyl 515 is for use in cleaning metal and for providing a film which provides both lubricating qualities and temporary protection against corrosion.

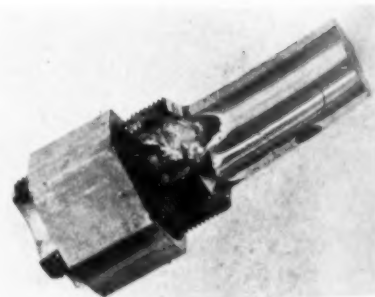
Tectyl 511 is designed to remove water from contact with metal in order to prevent corrosion, where machinery or metal parts have been immersed in water.

Tectyl 502 is a metal preservative for use on parts of machines stored or used indoors.

Tectyl 506 is used on parts or machines stored or used outdoors.

A Fast Repair of A Special Tap

In a large mid-west plant, a special $\frac{1}{8}$ " tap was shattered in service. It broke in ten pieces of various sizes and shapes and threatened to tie up production on an important job. A check-up with tool manufacturers brought the advice that a new one could not be delivered for six weeks so the tool maintenance department decided to attempt a repair. The head of this department, familiar with high speed steels, knew that welding was impossible but had a hunch that low temperature silver brazing alloys might do the trick. He had all parts cleaned carefully and fluxed with a low temperature flux. Parts were then assembled and held closely together in a milling machine vice. Heating was done with an oxy-acetylene torch and the alloy used was "Easy-Flo", of Handy & Harman, New York, a medium silver alloy flowing freely at 1,175° F. The exceptional penetrating qualities of this alloy, it was felt, would let it flow throughout the many surfaces that had to be joined. How well this repair was completed can be judged by the fact that the tap was back in service in four hours. That was last October. A report dated January 11, 1941 states that the tap is still in use. The actual brazing time for this job was but $\frac{1}{2}$ hour and but 3" of $\frac{1}{8}$ " diameter Easy-Flo wire was used to make the repair. The only fault detected after brazing was that the tap is 0.005" out of center, which made no great difference on the particular work being done. The job proved conclusively, however, that a braze of this type gives plenty of strength to withstand severe service conditions.



(Top) Ten pieces to be brazed. (Bottom) Finished tap only shows white lines where parts were joined.

Sizing Cement

Industrial Lubricants Co., Inc., 5736 12th Street, Detroit, Mich., manufacturers of polishing wheels, cement and allied products have announced a new product called "Grainlock sizing cement."

This sizing cement has been developed for use with the company's polishing wheel cement as a primer or base upon which to apply cement. The sizing is worked thoroughly into the polishing wheel, first against the nap and then in the opposite direction.

The sizing cement is said to form a fire-proof coating that penetrates into the cloth and thus reduces the danger of burned wheels, to a minimum. It also is claimed to prevent "breaking out" and glazing.

Hot Water System

A gas-fired forced circulation hot water system which has been installed in the factory of *Northrop Aircraft, Inc.*, Hawthorne, Calif., is credited with affording a flexibility of operation for metal treating tanks which could not be obtained with electrically operated tanks under the conditions prevailing in this plant.

The heating plant consists of two gas-fired low-pressure steam boilers which supply hot water through a piping system to ceiling mounted projection heating units scattered about the factory. The heating plant also supplies low-pressure process steam to cadmium plating and anodic tanks in the metal treating department in which small plane parts are cadmium plated or chrome treated in anodic tanks. The tanks are equipped with Minneapolis-Honeywell electric controls operating motorized valves.

Results obtained with the metal tanks in this factory are regarded as justifying the decision to use the same gas-fired boiler plant for supplying heat to the main factory and steam to the metal treating room. In addition to providing speedy and trouble-free operation, steam is credited with giving greater flexibility or range in tank operation, because the tanks are not subject to the definite limitations of electrically operated units. A 10-kw tank, for instance, has a range up to but not beyond 10 kw. The Northrop steam system, it is claimed, is capable of meeting any reasonable over-demand. This is regarded as of considerable advantage in this plant because the number of small parts moving through the metal treating room varies in accordance with the size of orders handled by Northrop for other plane companies, and seldom is the same from week to week.

This setup also becomes a factor in operating economy for the plant as a whole as compared with the operating cost of a direct gas-fired heater system, which was originally considered, in that a substantial saving occurs in the gas bill. Gas supplied to a direct gas-fired unit heater can be used for one purpose only—heating. Gas brought into a main boiler, as is the case at the Northrop plant, can be made to serve other purposes, such as supplying the steam for operating metal treating tanks.

"DEVELOPED and MANUFACTURED by EXPERIENCED PLATERS"

NO ONE is in a better position to judge the merits of a product than those who use it day after day and year after year. It is for that reason that "Micro Products" were developed and today are unequalled for their specific uses.

The plating plant of the Michigan Chrome and Chemical Company is one of the finest in the Middle West.

Here hard and decorative chromium plating is done, as well as plating with copper, nickel, tin, cadmium and silver. In such a plant, protective coating materials are put to every conceivable test. Up until two and a half years ago, there were no such materials that met all of our requirements for effective protection and proper economy. It was then that "Micro Products" were first produced—primarily for use in our own plating operations and, as manufacturing facilities permitted, they were made available to platers everywhere.

Today, the "Lacquer Plant" is in a spacious new building immediately adjoining the two buildings which house the plating facilities. Experienced chemists have at their disposal the most modern laboratory equipment. Of most importance, however, is that, as "Micro Products" are produced, they are subjected to more than theoretical tests. They are constantly in use in our plating departments. If there should be any "bugs" in the materials, we are the first to know about them.

Micro-Supreme Stop-Off Lacquers, Miccrolite or Miccrolac are made for platers by platers. That's why they can be depended upon to do your job.

WRITE FOR FULL DETAILS

MICHIGAN CHROME & CHEMICAL CO.
6348 EAST JEFFERSON
DETROIT, MICHIGAN

New Detergent Developed

An entirely new type of synthetic detergent, which is a non-electrolyte, and therefore compatible with most types of materials, has been developed for metal cleaning work by Rohm & Haas Company, 222 West Washington Square, Philadelphia. Known as Triton NE, the new material is a high molecular weight complex organic alcohol. It is non-ionic and readily soluble, even in strong salt solutions. It is manufactured as a viscous, transparent, pale amber liquid.

According to Rohm & Haas chemists, Triton NE was developed as a completely non-ionic, ash free material to obtain greater cleansing action in alkaline or acid solutions or in hard water where ordinary surface active agents are inactivated. The new material does not settle out, has the same specific gravity as water, is readily soluble in water.

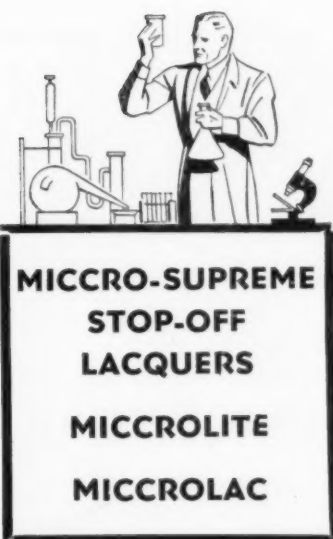
Its complete compatibility with acids, salts, and bases makes Triton NE useful in the

electroplating and metal-cleaning field. Since it is not an electrolyte it opens new possibilities to the electroplater.

Low Temperature Welding and Brazing

Eutectic Welding Alloys, Inc., 40 Worth St., New York, N. Y., have announced a series of eutectic welding alloys with suitable fluxes for welding and building up such metals as cast iron, steel, copper alloys, aluminum, magnesium, zinc base die castings and nickel alloys.

The low temperature of welding, made possible by the low melting eutectic alloys, is claimed to enable welding with a minimum of internal stress, warping, overheating, leaks and breaks, and is stated to obviate expensive preparation, pre-heating and machine troubles. High tensile strengths are claimed for the various welding alloys, and for example, "Castolin" No. 14 for casting iron is reported to have a tensile strength



METSO CLEANING *Passes* RIGID INSPECTION



Cadmium Plated
Flasher Shells

Do you clean electrolytically, in soaker tanks or by barrel or spray washers? Depend on Metso for thorough, reliable cleaning for all metal cleaning.

Metso Cleaners speed up wetting and grease and oil removal. Dirt thus removed is

prevented from redepositing onto cleaned surfaces through the unique properties of Metso's silica (SiO_2) content.

If you're working with soft metals such as zinc, tin or aluminum, the silica content protects them against chemical attack.

METSO CLEANERS—a family of silicate of soda cleaners for metal finishing

PHILADELPHIA QUARTZ COMPANY

General Offices: 125 S. Third St., Phila., Pa. Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities. Sold in Canada by National Silicates Ltd., Toronto.

EST. 1831



METSO CLEANERS

of 47,000 pounds per sq. in., and No. 16 for steel, as high as 117,000 pounds per sq. in.

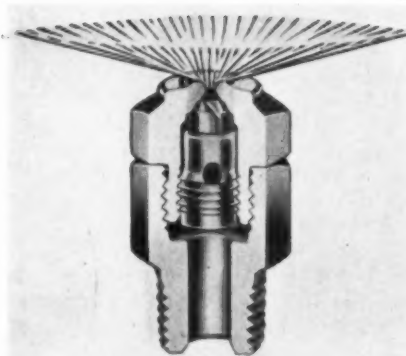
The alloys are recommended as being excellent for both production welding and reclamation welding.

A technical bulletin is available giving information on alloys and their fluxes.

Wide Angle Atomizing Nozzle

Spraying Systems Co., 4019-21 W. Lake St., Chicago, Ill., have developed a new "Parasol" type atomizing spray nozzle as illustrated.

The manufacturer reports that the spray is the hollow cone type with uniform distribution and exceptionally wide spray angle. They are of sturdy construction, accurately machined with polished orifice insert and are now available with male and female $\frac{1}{4}$ " pipe connection. Capacities range from 4 to 16 gallons per hour at 60 pounds pressure.



Wide angle atomizing nozzle.

The nozzles can be had with or without strainer. Standard stock construction is brass with 18-8 stainless steel inserts; other materials can be specified.

The nozzles are recommended for spraying inside of cylindrical objects or wherever an exceptionally wide spray angle is required.

Manufacturers' Literature

Abrasives

The National Metal Abrasive Co., 3560 Norton Rd., Cleveland, Ohio, have just issued a handbook entitled, "The ABC and XYZ of Cleaning, Hardening, Surfacing, Relieving Metal Fatigue, Strain, Etc." It treats rather extensively on metal abrasives, abrasives of yesterday and those of today; types of abrasives; difference in action between shot and grit; how shot and grit are graded; opportunities afforded by "controlled abrasives"; definite characteristics of abrasives to consider when buying them; how to figure the price of abrasives when purchasing; craters caused by peening action of shot; sizes of shot and grit troubles and their cures. The booklet is illustrated, and contains tables and charts. A copy will be sent free to anyone interested and writing to the above company on business letter-head.

Blackening Process for Zinc and Its Alloys

The Enthone Co., 442 Elm St., New Haven, Conn., have issued a 6-page folder, describing and giving working directions for the company's "Ebonol Z" process for immersion blackening of zinc and its alloys. This process is also used for blackening non-reactive metals, such as stainless steel, using contact with zinc in the blackening solution.

Blowers

Breuer Electric Mfg. Co., 5100 N. Ravenswood Ave., Chicago, Ill., have published a 4-page folder describing their new "3 in 1 Tornado Blower-Model 10A". This blower is connected to 110 volt electric circuit and is said to produce a blast of air with a velocity of 295 miles per hour. They are used for blowing off dust and chaff from difficultly accessible places. They also can be used as a vacuum generator, giving suction velocity of 175 cu. ft. per minute. With a special attachment, they can be used for spraying and are claimed to send a spray 20 to 30 ft. in a fine mist. Smaller sized blowers are also available.

Cleaning Non-Ferrous Alloys

Oakite Products, Inc., 18 Thames St., New York City, have published an illustrated, 4-page feature article appearing in the January-February issue of "Oakite News Service" on a newly developed procedure designed especially for cleaning brass, copper and zinc alloys before plating, and which is reported to provide more certain and complete removal of oil, grease, smutty deposits and soap films to assure better plate adhesion. Written by Edwin C. Rinker of the Oakite Research Laboratories, the article states that this new method consists of three principal steps: (1) effective pre-cleaning of work either with an emulsifying solvent

or an alkaline compound, depending upon the condition and shape of the work; (2) anodic cleaning with an alkaline electro-cleaner designed specifically for this purpose, and (3) a sulfuric acid dip. Rinsing, of course, follows each operation. Beyond producing more complete removal of foreign matter than is possible with various other cleaning methods generally used heretofore, this new cleaning process is also said to prevent formation of soap films when the cleaner becomes contaminated with soap and to provide other substantial advantages. Copies of this article are available upon request by writing to the company.

Control Instruments

Wheelco Instruments Co., 1929 S. Halsted St., Chicago, Ill., have issued Bulletin No. Z4000 superseding No. G2000-5, which is a condensed catalog of control instruments and accessories as furnished by the company. Twelve pages are used to describe and illustrate remote controls for automatic weighing, liquid level control and flow or differential pressure control. Pyrometers, temperature control instruments, portable potentiometers, and various types of indicating thermometers and pyrometers are described and illustrated.

Diaphragm Pump

T. Shriver & Co., 810 Hamilton St., Harrison, N. J., have recently issued their Bulletin No. 112, which consists of 4 pages in blue and white for describing and illustrating the company's diaphragm pump. Some of the features described and claimed for the company's pump are: positive action, perfect lubrication, no leakage, easy to clean, simple routine maintenance, ample pressure and low cost operation. The pumps can be built of almost any metal and some of the metals used are cast iron, bronze, lead, nickel, Monel metal, stainless steel, aluminum, and metal can be supplied lined with soft, semi-hard or synthetic rubber. Typical installations of the pump, such as for use with filter presses, are illustrated.

Dust Control

American Air Filter Co., Inc., Louisville, Ky., have put out an 8-page folder describing and illustrating the company's "Roto-Clone Dust Control". These controls are used for removal of dust, from rough snagging in foundries, to the finest finish grinding in the production of precision equipment. Typical installations are shown.

Laboratory Apparatus Catalog

The American Instrument Co., Silver Spring, Md., have published a new catalog of laboratory apparatus. The catalog contains 184 pages describing instruments and apparatus for chemical, biological, physical, clinical, pathological, research, engineering and materials testing laboratories. It presents recent additions to the company's line and includes useful data that enable the laboratory worker to select the most suitable and reliable controls and other de-

CHROMIC ACID

99.75% PURE

Stocks of Mutual Chromic Acid are available in all principal industrial centers, where Mutual distributors stand ready to give complete technical service supplemented and supported by the research and development facilities of the world's largest manufacturer of chromium chemicals.

BICHROMATE OF SODA
BICHROMATE OF POTASH



Mutual Chemical Co. of America

270 MADISON AVENUE, NEW YORK

vices for constant temperature applications. Another new feature is the section devoted to laboratory and field instruments used by soil chemists, agricultural chemists and agronomists. This catalog is available upon application on business or professional stationery. Ask for catalog XY 41.

Pre-Finished Metals

American Nickeloid Co., Peru, Ill., have recently published a 6-page folder entitled, "Hand-in-Hand", which describes the company's pre-finished metals for use in fluorescent lighting fixtures. Samples of bright and satin finished chromium plated steel are attached.

Respirator Eyeshields

Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa., have recently brought out Bulletin No. CR-7, which describes their respirator eyeshields. These eyeshields are made from clear plastic,

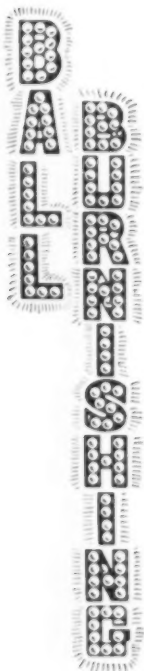
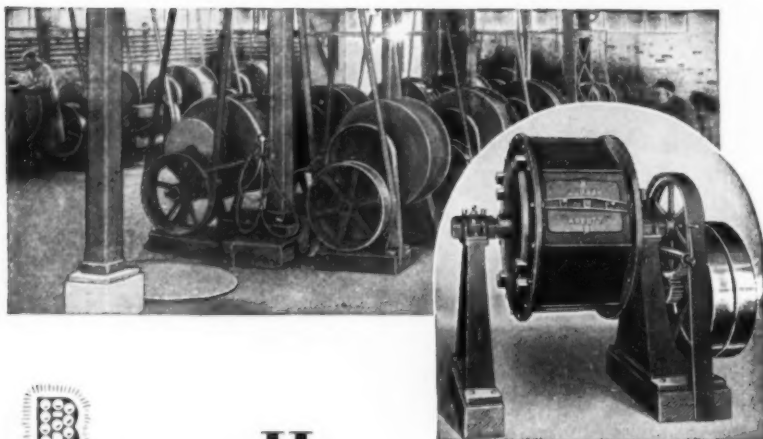
and are said to be durable and non-inflammable, and allow unhampered air circulation between the wearer's face and the eyeshield, thus preventing fogging and assuring wearing ease. The use of eyeshields with two types of the company's respirators is illustrated.

Sodium Silicate Adhesive

Grasselli Chemicals Dept. of E. I. duPont de Nemours & Co., Wilmington, Del., have issued a new bulletin describing the use of their sodium silicates as adhesive, binder, detergent and deflocculant. The bulletin contains a chart indicating a wide range of applications. Various grades and their specific uses are also listed. The chemical is manufactured in solutions ranging from thin syrupy liquids to a viscous and slow-moving mass.

Tanks

Hanson-Van Winkle-Munning Co., Matawan, N. J., in their Bulletin No. T-104, en-



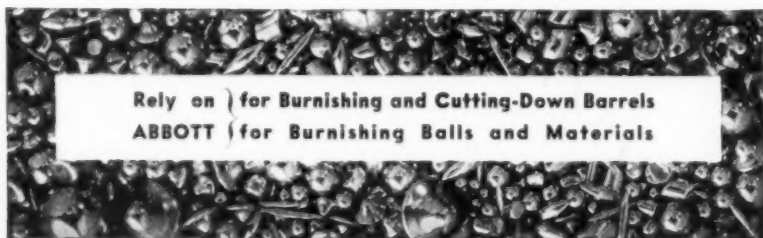
HERE'S the production way to finish small parts at a profit. You can measure output in terms of pecks instead of pieces, because Abbott barrels handle up to nine pecks of small stampings or similar parts in one load. Efficient, low-cost production is the result. Picture the savings in your own plant—savings that will offset current increases in material and labor costs.

Plants now having burnishing equipment can save money with Abbott materials. Their tool steel structure not only makes frequent replacements unnecessary, but actually produces a finer finish.

Write today for complete information. For many companies, that has been the first step toward the solution of difficult finishing problems.

The Abbott Ball Company

1046 New Britain Ave., Hartford, Conn.



Rely on } for Burnishing and Cutting-Down Barrels
ABBOTT } for Burnishing Balls and Materials

titled "Tanks", describe and illustrate wooden, welded steel and rubber-lined tanks for plating and metal treating purposes. Specifications are given for these tanks and for earthenware tanks, spray rinse tanks, electrolytic polishing equipment and various accessory equipment, such as steam joints, sawdust boxes, bus bars, agitators, rod and wire connections.

Welding Alloys

Eutectic Welding Alloys, Inc., 40 Worth St., New York City, in a 6-page folder describe their eutectic alloys and fluxes for low temperature welding and building up of cast iron, steel, copper and its alloys, aluminum, magnesium, zinc, nickel and their alloys.

Water Treatment

American K.A.T. Corp., 122 E. 42nd St.,

New York, have issued a new booklet entitled "The Water Treatment Science of Tomorrow in Today's Engineering", which explains the theory of organic colloidal action and briefly discusses the trend in water treatment.

Associations and Societies

Electrochemical Society

The 79th convention of the society will be held at the Hotel Cleveland, Cleveland, Ohio, April 16-19.

R. S. Mackie is chairman. The full program and the titles of papers to be presented were given on page 151 of the March issue of Metal Finishing.

American Electroplaters' Society

Annual Meeting of Local Branches

New England Meeting

Five co-operating branches of the A.E.S., namely, New Haven, Bridgeport, Hartford, Springfield and Waterbury, will hold a joint educational session and banquet at the Stratfield Hotel, Bridgeport, on Saturday, May 3d.

The educational program is being arranged by the Waterbury Branch and Bill Gray will be technical chairman. New Haven Branch is handling the advertising; Springfield Branch, the publicity; Hartford, finance, and Bridgeport will take care of hotel and entertainment.

The educational session will start at 2:30 P.M., and the dinner at 7:00 P.M. in the evening. R. J. O'Connor, Contract Plating Co., Stratford, Conn., is general chairman.

Milwaukee Branch

The annual educational session and banquet will be held at the Schroeder Hotel on April 26th.

The educational session will start at 2:00 P.M. in the Green Room of the Schroeder Hotel, and will have the following speakers:

1. R. F. McGuire, Donald Sales and Mfg. Co., "Rust Proofing with Cadmium".
2. Wm. C. Geissman, "The Chemical Engineer and Electroplating".
3. Vincent Mattacotti, Hanson-Van Winkel-Munning Co., subject to be announced later.

The banquet will start at 7:00 P.M. in the Crystal Ball Room, with entertainment and dancing to follow. Reservations: \$3.00.

Robert Steuernagel, 2370 N. 32nd St., Milwaukee, Wis.

Newark Branch

The annual educational session and banquet will be held Saturday, April 26th at the Hotel Robert Treat, Park Place, Newark, N. J.

The educational session will start at 2:30 P.M., with the following speakers and subjects:

1. Dr. Walter R. Meyer, Editor, Metal Finishing, "Engineering Aspects of Electroplating."
2. George B. Hogaboom, Engineer, Hanson-Van Winkel-Munning Co., Matawan, N. J., "Design for Finishing."
3. H. E. Haring, Bell Telephone Laboratories "Corrosion."
4. Floyd Oplinger, Assistant Manager, Electroplating Div., E. I. duPont de Nemours & Co., Niagara Falls, N. Y., "Tin Plating and Its Application."

The speakers and their subjects were selected to emphasize the importance of plating to the Defense Program. Other technical societies have been invited to attend the meeting.

A dinner and dance will be held in the evening with a top notch floor show.

Spring Meeting of Ohio Branches

Representatives of the Toledo, Cleveland and Dayton Branches held a meeting at the

Biltmore Hotel in Dayton, Saturday, March 8, when tentative plans were formulated for a joint spring educational meeting. These plans call for an outdoor meeting in Cleveland, Saturday, May 10th.

Toledo has assumed responsibility for the advertising; Dayton for the educational program, and Cleveland will act as host and provide the dinner and entertainment.

Much credit is due President *Miner* of the Toledo Branch, for taking the initiative in this project.

Plans call for rotation of these affairs among the three Branches from year to year, and are under way whereby *Anderson*, *Indianapolis* and *Cincinnati* will be included in a similar group. This will complete the list of all the branches which have in recent years made the annual meetings so popular that they even rival the National Convention, in some cases.

Watch for the announcement of the final plans for this meeting in our next issue.

Chas. C. Conley, National 3rd Vice-President is in charge of educational activities.

Los Angeles

Making a strong bid for the national society's membership drive gold cup, Los Angeles Branch received 19 new applications for membership at its March 12 meeting at the Rosslyn Hotel.

The new group included 10 applications for active membership, six for associate, and three for reinstatement as active members, making a total of 43 new members received during the current drive and bringing the branch's total membership to 102. With latest reports showing the branch with a 40.8% increase in membership in the national batting order since May 1, 1940, placing it second only to Lancaster (Pa.). Branch, heads of the Los Angeles membership drive committee consider that they have an excellent chance of winning the trophy.

Feature of the educational program at the meeting was a motion picture entitled "The Alchemist's Hour Glass," which depicted the manufacture of abrasives and their various uses in industry.

Final details of the educational and entertainment program to be presented at the branch's annual educational session on March 22 were also decided at the meeting.

New Books

Ingot Brass and Bronze. Issued by Non-Ferrous Ingot Metal Institute, 308 W. Washington St., Chicago, Ill.

The price of this manual was erroneously given as \$2.00 per copy in the February issue of *METAL FINISHING*. The price of this manual is \$5.00 per copy, and for purchasers within continental United States, this price includes delivery charges and copies of supplemental pages that may be issued up to December 1, 1942, with no additional charge. To purchasers without continental United States, the price is \$5.00 per copy plus trans-

portation charges, with no obligation to supply supplemental pages without special charge.

Chemical Analysis of Aluminum. By H. V. Churchill and R. W. Bridges. Published by Aluminum Company of America, Pittsburgh, Pa. Size 5 1/4" x 8 1/4"; 116 pages. Price 50 cents.

The methods for the analysis of aluminum, standardized and developed by the chemists of the Aluminum Company of America, are revised in this second edition.

A short review of the development of methods of analysis is given; solution of aluminum and separation of aluminum are outlined. Various methods for the analysis of impurities in aluminum, such as copper, silicon, iron, titanium and vanadium are given. Metals commonly alloyed with aluminum are discussed as well as the determination of less common constituents of aluminum alloys, such as antimony, arsenic, barium, beryllium, bismuth, boron, cerium, etc.

RACK INSULATION MAKES HIT WITH PLATERS

"100 RACKS COATED—
ADDITIONAL 200 ON ORDER!"
USER REPORTS

NEW YORK, APRIL 1.—United Chromium's "Unichrome" Rack-Coating-W continues to make news in the plating industry. Trial applications produce results so satisfactory as to be quickly followed by general adoption. "Have 100 racks coated and 200 additional on order," a prominent plater states. This is a typical reaction to the unique combination of advantages this material offers. These advantages are:

1. Withstands boiling cleaners and all plating solutions
2. Tough—withstands wear and tear of handling
3. Contains no ingredients harmful to plating solutions
4. Cuts costs—reduces frequency of recoatings
5. Easy to apply—"dip and force dry" method
6. Light in color—easy to see how well the rack is covered
7. Any part of rack can be recoated without recoating entire rack.

Write for Bulletin 27

Containing Complete Information—

Platers without rack coating facilities may have their racks coated with "Unichrome"™ Rack Coating-W by Chromium Corporation of America, 4645 West Chicago Avenue, Chicago, Ill. Belke Manufacturing Company, 947 North Cicero Avenue, Chicago, Ill. or United Chromium, Inc., of Waterbury, Conn.

**UNITED
CHROMIUM**
INCORPORATED

51 East 42nd Street, New York, N.Y.
2751 E. Jefferson Ave., Detroit, Mich.
Waterbury, Conn.



Trade Mark
Reg. U.S. Pat. Off.

The book is bound with spiral wire binding, which makes it easy to hold to any particular page in the book.

The Metallurgy of Deep Drawing and Pressing. By J. Dudley Jevons, with a foreword by H. W. Swift. John Wiley & Sons, Inc., New York. Size 10" x 6"; 683 pages. Price, \$10.00.

This is a comprehensive and excellent book discussing almost all phases of the subject. The volume is intended for both practical workers and scientific students, and is thoroughly illustrated with excellent photomicrographs, drawings, shop views and equipment.

The book opens with a discussion of the production of brass sheet. Following this, the production of steel sheet is outlined. Defects and difficulties experienced in drawing are then discussed in detail. Some of the defects discussed include those inherent in the metal, due to impurities, inclusions, segregation and gas cavities. The effects of

COWLES UX CLEANER

Designed TO REMOVE SMUT



★ Cowles UX Cleaner is a scientifically designed heavy duty material for cleaning steel, particularly where a smut condition is encountered. UX Cleaner contains emulsifying and wetting agents and may be used in either direct or reverse electro cleaning as well as still tank.

To simplify and speed up your steel cleaning operation investigate COWLES UX Cleaner today. A Cowles representative will be pleased to furnish you with complete information, or you can write us.

variation in thickness, unsuitable crystal structure, preferred orientation and other defects are outlined. Following this, troubles attributable to the inherent design of the article to be produced, are discussed. Specific difficulties of various metals with suggestions for their prevention are considered. Some of these include stretcher strains, hydrogen embrittlement, season cracking, blue brittleness. The deep drawing of aluminum alloys, magnesium alloys, nickel silver, zinc, stainless steels and various alloy steels, and presses and tools for the drawing of metals are then described. The theory of lubrication and lubricants are then considered. Some of the other chapters are: Testing of Sheet Metal; Properties which Determine the Behaviour of Metal During Deep Drawing; Specification; New Applications of Deep Drawing and Pressing; Desired Improvements in Metal; Desired Improvements in Press Shop Procedure.

In the appendix is presented a discussion on the Application of x-ray examination. A list of 135 references is given.

This outstanding work is recommended

to all those concerned with the making and fabrication of sheet metal; to chemists, engineers, press room foremen, mill men and lubricant engineers.

Phenomena at the Temperature of Liquid Helium. By E. F. Burton, H. Grayson Smith and J. O. Wilhelm. Published by Reinhold Publishing Corp., New York. Size 9" x 6"; 352 pages. Price, \$6.00.

This book aims to correlate and discuss information available on phenomena at low temperatures. The historical introduction discusses artificial refrigeration, the liquefaction of gases and the Joule-Thomson effect. Various methods for liquifying such gases as air, hydrogen and helium are described in the second chapter. Following this are considered various methods of temperature measurement for low temperatures. The physical properties of liquid and solid helium are then outlined.

The book concludes with a discussion of the transformation in liquid helium and the nature of helium II.

Business Items

New Harshaw Appointments

Howard Haney, manager Pittsburgh office of The Harshaw Chemical Company, has been appointed division manager of the company branches at Pittsburgh and Cincinnati. Within a short time Mr. Haney expects to make his headquarters at the Cincinnati office. Paul Huntley has been appointed assistant manager of the Cincinnati office. Richard Brian has been appointed assistant manager of the Pittsburgh office.

George B. Beitzel, manager of sales of the Pennsylvania Salt Manufacturing Company, manufacturers of a long line of well known Pennsalt metal cleaners, has been elected president of the Sales Managers' Association of Philadelphia and will assume his duties at the Fall meeting of the Association.

Mr. Beitzel is well known in the metal cleaning industry, having been connected with the Pennsylvania Salt Manufacturing Company for the past eleven years, and his selection for this honor will be heartily approved by all of his friends.

L. M. Rice Promoted by American Cyanamid & Chemical Corp.

On March 1st, general sales manager Campbell of the American Cyanamid and Chemical Corp., 30 Rockefeller Plaza, New York, announced the appointment of L. M. Rice as assistant sales manager of the company's Organic Chemicals Department.

Mr. Rice's entire business career has been with the Cyanamid organization, and he has been associated with the sales of the company's following products: insecticides, sodium cyanide, case hardening compounds, aqua ammonia, D.P.G., and fumigation by hydrocyanic acid. He later promoted the sales of the company's ethyl lactate and ethyl oxybutyrate, and then the new Rezyl and Teglac synthetic resins.

Mr. Rice is a graduate of both Hamilton College and M.I.T., and is a member of Phi Beta Kappa, Alpha Chi Sigma and Theta Delta Chi.

B. F. Bower Leaves Howell Company

B. F. Bower, formerly chief engineer of the Howell Company, St. Charles, Ill. advises of his resignation from that company as of March 1, 1941.

Mr. Bower has spent many years in designing and perfecting tube fabricating equipment and other metal working machines for making tubular steel furniture, many modern day machines being of his design.

At the moment he is organizing a company which will shortly go into production on tube fabricating machines, an announcement of which will be made as soon as suitable plant facilities are secured.

As a recognized designer of equipment of this type, this new organization will shortly offer a complete line of tube bending, burring and cutoff machines of high speed type.

The Glyco Products Co., Inc., have moved their offices, plant and laboratories from 148 Lafayette Street, New York City, to larger quarters in Brooklyn. The building, which was erected to their specifications, has greatly improved shipping means, such as railroad sidings, water freight facilities, etc.

A considerable amount of new and modern equipment has been installed by the company to increase and improve production facilities.

The new address is 230 King Street, Brooklyn, N. Y., and the telephone number MAin 4-1760.

Rush of orders incidental to the national defense program has made it necessary for Marcus Rynkofs, president of Liberty Plating Co., 525 North LaBrea Avenue, to reopen a former shop which he had closed some four years ago.

The shop is located at 1354 West 25th Street, Los Angeles. It has been completely remodeled and equipped with new machinery to handle the 7-ft.-long units in the form of sewer traps and other plumbing accessories which Mr. Rynkofs is handling on a sub-contract basis. Bright nickel, chrome and nickel tanks have been installed, together with auxiliary equipment. Walter Olyphant has been made superintendent of the West 25th Street plant, while Stanley Rynkofs, a son of the head of the firm, continues as foreman of the LaBrea Avenue shop.

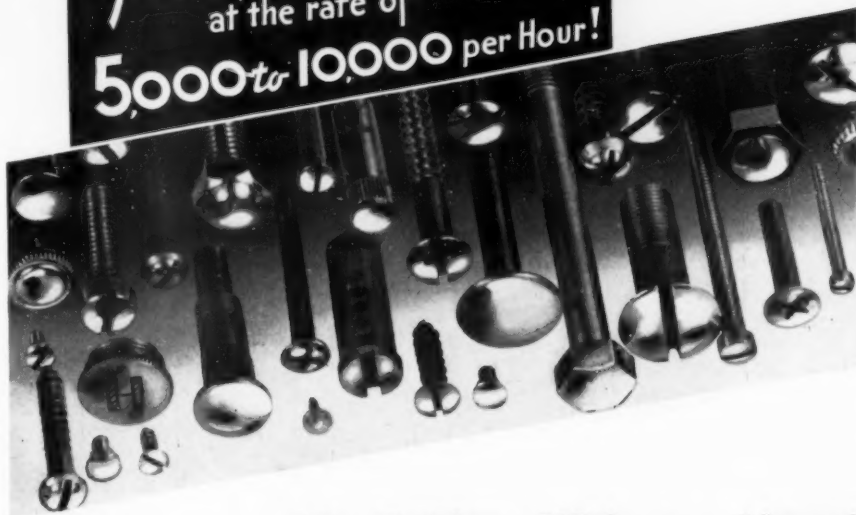
Technical Enameling & Plating Co. has completed organization details and has opened for business at 1726 Standard Avenue, Glendale, Calif. E. R. Chilcott, president of Technical Products Co., heads the new firm as president and still retains his interest and activity in Technical Products Co.

E. S. Bennett, formerly associated with Metal Finishing Co., whose plant burned down recently, is vice-president and secretary; and J. T. Moore of the Moore Enameling & Plating Co. is vice-president and treasurer. Clarence Floyd has been appointed shop foreman of the new company.

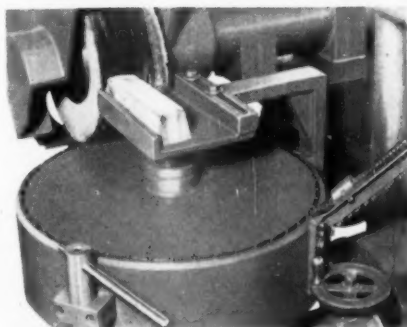
New equipment installed includes lathes, chrome, copper, nickel and cadmium tanks, tumbling and plating barrels, and generators. The firm is equipped to engage both in job work enameling and plating and in contract work on plane parts for Glendale, Burbank and Los Angeles accessory factories which supply parts to Lockheed Aircraft Corp. and Vega Airplane Co. Finishing room operations of Technical Enameling & Plating Co. include buffing, polishing, plating, enameling and oxidizing.

Hughes Aircraft Co., Union Air Terminal, Burbank, Cal., has let general contract for a new experimental aircraft works on 300-acre tract at Inglewood, Cal., consisting of three one-story and basement structures, all with mezzanine floors, 220 x 300 ft. for assembling; 150 x 240 ft. for processing department, and 75 x 150 ft. for foundry; also a two-story and basement engineering building, tumbling, polishing, buffing, barrel bur-equipment. The following departments are operated: sand or shot blasting, grinding, pickling, anodizing, plating, metal spraying, lacquering and painting.

Screw Heads
Polished or Buffed
at the rate of
5,000 to 10,000 per Hour!



It's Quicker With an "Acme"!



Acme Type "SM"

For polishing or buffing flat or oval-head screws—also hinge pins, rivets, lock barrel facings and other cylindrical parts—an Acme "SM" Automatic is three to six times as efficient as the old method. Besides, it produces a better finish, with a minimum of rejects.

This is, of course, but one of the many types of Acme polishing and buffing machines in widespread use for speeding up production and reducing operating costs. If you have a buffing or polishing problem, the chances are there is an Acme machine that will solve it.

**Send Sample for
FREE Production Estimate**

ACME Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.

Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

Timm Aircraft Co., Van Nuys, Calif., has taken the initial step toward eventual installation of its own plating plant by the acquisition of anodizing facilities for a new department to be used for chromodizing airplane parts and gasoline tanks. The company's plating is still being handled by outside finishing shops. Timm Aircraft Co. opened for business about a year ago for the manufacture of plastic planes.

Ampco Metal, Inc., 3830 W. Burnham Street, Milwaukee, Wis., metal products, have let general contract for a one-story addition, 50x150 feet. Cost close to \$50,000 with equipment.

Trumbull Electric Mfg. Co., Plainville, Conn., electric switches, starters, panelboards, feeder distribution systems, has purchased buildings at Section Avenue and line of Baltimore & Ohio R. R., Norwood, Cincinnati, Ohio, for a new branch plant to

supersede former factory at Ludlow, Ky. Cost over \$150,000 with equipment. The following departments are operated: grinding, tumbling, polishing, buffing, barrel bur-nishing, descaling, pickling, cleaning, degreasing, plating, lacquering, enameling, japanning and painting.

L. R. Schlundt, manager of Republic Lead Equipment Co., 7930 Jones Road, Cleveland, Ohio, has announced that MacDermid, Inc., Waterbury, Conn., will be the New England agents for Republic multi-edge anodes for chromium plating.

American Buff Company, manufacturers of bias type and other type buffs, have announced the removal of their office and factory to 711 W. Lake Street, Chicago, Ill. The new location, which provides increased facilities for manufacturing and service, was necessitated because of the increased demand for the company's products.

DON'T YOU HEAR

THAT WHISTLE

BLOWIN'?

The chances are, if you're in the metal finishing department you *don't* hear the five o'clock whistle.

If you hear it, you probably don't heed it. Metal finishers don't work by the clock. They work by the job.

We know this because for more than thirty-three years we have been working with metal finishers, helping them to clean metal prior to painting, plating, lacquering, enameling . . . prior to almost any finish metal will take.

Wyandotte Service Representatives are on call all the way 'round the clock. They work on special jobs in metal finishing plants the country over, and they bring the combined experience of the entire Wyandotte organization to every job they tackle.

Do you have a metal cleaning problem now? There is a trained Wyandotte man ready, and able, to help you—without obligation. Call us today.



Members in attendance at the Central Region Sales Meeting of service representatives and office executives of the J. B. Ford Sales Co., Wyandotte, Mich.

Ralph Granquist of the Hanson-Van Winkle-Munning Co., Chicago sales organization, and Mrs. Granquist were visitors to Los Angeles during the early part of March. Mr. Granquist combined business with pleasure, taking advantage of his presence in Southern California to call upon several former associates from the Chicago territory.

L'Hommedieu to Exhibit at Western Congress

Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., are to exhibit at the Western Metal Congress, to be held in Los Angeles in May.

The company will be represented by S. L. Cole, sales manager, and Albert Locke.

The company will feature products available to the plating industry.

Royal F. Clark, Sr., has accepted the position as foreman in the gold plating department of Harry C. Schick, Inc., Newark, N. J., jewelry manufacturers.

Quaker Chemical Products Corp., Conshohocken, Pa., have announced the association of R. E. Scott with their company. Mr. Scott was formerly chief chemist of the Marlin-Rockwell Corp., Jamestown, N. Y., and has had extensive experience in the application of cutting oils, grinding compounds, rust preventives and both the alkaline and solvent type cleaners used in metal processing. He has been added to the company's technical sales force in the northern Ohio territory, and his headquarters are at 320 Beech St., Berea, Ohio.

Wyandotte Service Men Hold "Preparedness" Conference

Fifty-four central region Wyandotte service representatives and ten home office executives of the J. B. Ford Sales Co., Wyandotte, Mich., held a "Preparedness" conference in Cleveland, Ohio, at the Statler Hotel, February 27 and 28.

The important part that cleaning operations of all kinds are playing in the present National Defense Program, was the featured topic of this conference. Metal cleaning operations of all kinds as well as other operations, such as dishwashing, laundering and sanitation in food and beverage plants, were discussed. In addition, maintenance cleaning, processing of textiles, the cleaning of armament, army equipment, such as blankets, helmets, dishes, silverware, etc., were thoroughly considered.

The company has developed more than 100 different specialized cleaning materials.

G. T. Robinson, central region supervisor and chairman of the conference, introduced the following home-office executives: C. B. Robinson, president The J. B. Ford Sales Co.; W. F. Torrey, secretary and treasurer; H. A. Gage, assistant controller; Robert Rane, advertising manager; W. B. Appleby, assistant manager Laundry and Textile Dept.; W. M. Cole, manager Industrial Dept.; V. R. Jones, manager Food & Beverage Dept.; H. A. Rightmire, manager Detergent Dept.; P. W. Soderberg, manager Technical Service and Dr. T. V. Vaughn, Research Dept.

Plating and Rustproofing Association of Michigan

The Plating and Rustproofing Association of Michigan, incorporated in 1938, have begun their fourth year. Their annual meeting was held Saturday, March 1st, at the Statler Hotel, Detroit, Mich. J. C. Nankervis of the Advance Plating Co., was elected to the board of directors, and Messrs. H. E. Adelsperger, Auto City Plating Co.; Charles Erdman, Central Plating Co.; Paul H. Henning, Detroit Plating Industries; W. B. Knight, Knight Plating Co.; Robert L. Reed, Robert L. Reed Co., and Percy L. Stapleton, Service Plating Co., were re-elected to the board.



Robert L. Reed

At a meeting of the board of directors, Robert L. Reed, was elected to the office of president for the year 1941-42, succeeding W. B. Knight. Charles Erdman, president of the Central Plating Co., was elevated to the office of vice-president, while Frederick R. Bolton was re-elected for the fourth year as secretary-treasurer.

The membership of the Association are fully cognizant of their importance in the present Defense Program in the maintaining of proper standards and in dissemination of information of value to fellow-members.

The Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., manufacturer of Thor portable power tools, moved into new headquarters at the end of March, occupying the new Thor building at the corner of 17th and Fairmount Avenues, Philadelphia. This new structure is a further step in a building program in which the company has been engaged for the past year, and which includes the erection of a new \$500,000 plant in Los Angeles, Cal.

Coleman Electric Co., Inc., 310 Madison St., Maywood, Ill., manufacturers of pH and similar instruments, have opened a sales and service office at 122 East 42nd St., New York City. D. A. Korman, formerly sales manager of Eimer and Amend, is in charge.



New Improved LUSTREBRIGHT BRIGHT NICKEL PROCESS

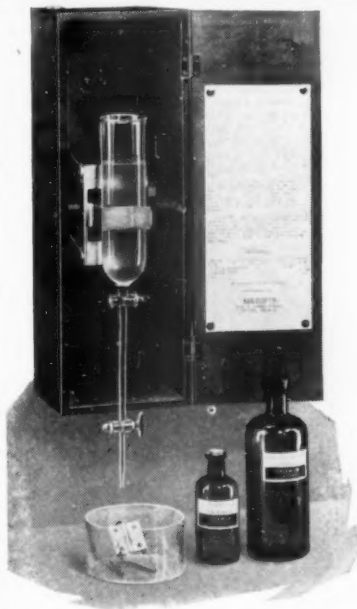
**PRODUCES BRILLIANT, LUSTROUS NICKEL DEPOSITS.
ELIMINATES COLOR BUFFING—RE-CLEANING—RE-RACKING.
AN IDEAL BASE FOR CHROMIUM. EXCELLENT THROWING POWER.
NO SPECIAL SOLUTIONS OR CHANGES IN EQUIPMENT REQUIRED.
EASY TO CONTROL—LOW IN COST—SUCCESSFUL—PRACTICAL.**

Uniform results obtained on all classes of work in still tanks or mechanical barrels. Excellent for zinc die-castings. Any cold nickel solution of standard formula will with the addition of NEW IMPROVED LUSTREBRIGHT give brilliant, lustrous, adherent deposits. Guaranteed not to harm plating solution or cause plate to peel, become brittle or produce streaky deposits. Illustration shows unbuffed deposits produced before and after addition of NEW IMPROVED LUSTREBRIGHT. Write for complete information.

W. C. BRATE COMPANY

EST. 1860

ALBANY, NEW YORK



CONTROL SOLUTIONS & DEPOSITS

METAL IS TOO DIFFICULT TO OBTAIN TO
WASTE IT

A complete line of Testing Sets for
controlling solutions and testing de-
posits.

Complete laboratory service.

Write for Leaflet

KOCOUR CO.

4720 S. CHRISTIANA AVE.
CHICAGO

McKEON'S

"Liquid Sulphur"
TRADE MARK REGD.

Will remove copper from steel, iron,
brass, zinc die castings, etc. without
destroying finish of bare metal.

Write for free special directions.

SULPHUR PRODUCTS CO.

Greensburg, Pa.

(Beans.—Learn about them at Boston—A.E.S. convention—June 9-10-11-12)

John Slezak, president of *The Turner Brass Works*, Sycamore, Ill., announces the appointment of *John W. Mock* as sales manager of the Liquid Fuel Appliance Division. Mr. Mock joined Turner a year ago, having had wide experience in direct selling and supervision, sales training and sales research. As sales manager, Mr. Mock will have charge of the 70th anniversary program which commemorates the company's founding in 1871.

Webster Electric Co., Clark & DeKoven Aves., Racine, Wis., transformers, public address systems and other electrical apparatus, are erecting two additions, 60 x 117 ft., and 60 x 100 ft. These will be completed in June. Cost close to \$100,000 with equipment. The following departments are operated: grinding, cleaning (alkaline), degreasing (solvent), lacquering, enameling and painting.

G. S. Rogers & Co., 228 N. LaSalle St., Chicago, Ill., processing materials manufacturers, have announced the appointment of the *Gordon A. Webb Organization*, 337 Curtis Bldg., Detroit, Mich., as Detroit and Michigan distributor of the company's products used in heat treating and finishing of metals. Gordon Webb and his organization are well known in the Detroit industrial field, and have been associated with manufacturers of materials and products used in the heat treatment and finishing of metals. Webb will have charge in the Detroit and Michigan areas of all sales, servicing and applications

of Rogers' products, which include solid and liquid carburizers, armor plate compounds, quenching, cutting and core oils, heat treating salts, rust preventives, drawing compounds, metal cleaners and lubricants.

Several changes in the sales staff of the mechanical division of *The B. F. Goodrich Company* are announced by *W. S. Richardson*, division general sales manager.

A. W. Doran has been assigned to special duties in connection with railroad and governmental sales. *B. E. Silver*, sales representative of the mechanical division in Indiana is transferred to government sales in Washington, D. C. and *W. E. Nees* appointed to his post, with headquarters in Indianapolis. *Ralph Barcus* of the Akron district staff succeeds Nees in the West Virginia territory, with headquarters in Charleston.

Ashland Henderson, chemical engineer, has been named to the technical staff of *Battelle Memorial Institute*, Columbus, Ohio. He has been assigned to a research investigation which is aimed at the development of metal surfaces resistant to wear, corrosion and chemical attack for specialized industrial uses.

Mr. Henderson was formerly metallurgist with the Frigidaire Division of *General Motors*. He possesses a master's degree from the University of Cincinnati and is a member of the American Society for Metals.

Patent Digest

Etching Solution

U. S. Patent 2,230,156 E. F. Carman, assignor to Interchemical Corp., January 28, 1941. A solution for etching lithographic plates and consisting of 1 part by volume 37% aqueous hydrochloric acid and 3 parts by volume of propylene glycol.

Plating Machine

U. S. Patent 2,228,672 C. G. Olson, assignor to Illinois Tool Works, January 14, 1941. A plating machine for coating the entering parts of thread cutting or tapping screws and fasteners.

Cleaning Apparatus

U. S. Patent 2,227,047 T. K. Webster, assignor to The Hydro-Blast Corp., December 31, 1940. An apparatus for cleaning castings by the use of guns fed with fluid under pressure and an abrasive material.

Acid Pickling Inhibitor

U. S. Patent No. 2,226,106 W. J. Ryan & M. T. Kendall, assignors to The Texas Co., December 24, 1940. An acid pickling inhibitor for steel consisting of acid sludge produced by acid treating cracked petroleum naphtha with dilute sulfuric acid.

Magnuson Says:

"PERMAG Cleaning Compounds aid in the Nation's Defense Program"



PERMAG Cleaning Compounds are widely used in Industries — especially in metal fabricating plants for cleaning metal surfaces. In these plants defense work is in progress.

PERMAG Cleaning Compounds clean aluminum and similar soft metals without injury to the metal. PERMAG is quick in action, thorough, economical and is absolutely guaranteed for its work.

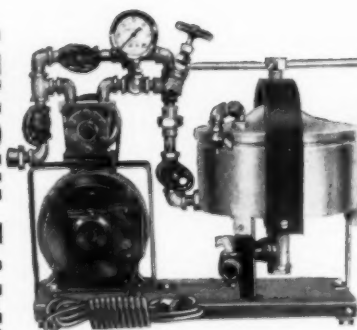
Let the Magnuson Research Service aid you in solving your cleaning problems. Write us. No obligation for an interview and a report.

PERMAG CLEANING COMPOUNDS
MAGNUSON PRODUCTS CORPORATION
HOYT & THIRD STS. BROOKLYN, N.Y.

Representatives from Coast to Coast. Warehouses in Principal Cities.
In Canada: Canadian Permug Products Ltd., Montreal and Toronto.

IMPROVE PLATING QUALITY

SAVE MONEY



with
SPARKLER
Horizontal-Plate
FILTERS

Portable . . .
Keep Tanks
Cleaner

Sparkler Horizontal-Plate Filter equipment is engineered to cut filtering time, improve plating quality and reduce costs. It filters all solutions—bright nickel, copper cyanide, zinc, cadmium, chromium, silver—faster, more efficiently than any other unit on the market. Ideal for reconditioning fouled solutions with activated carbon. Advantages include greater speed and capacity; compactness; portability—wheels up to any tank; intermittent service without disturbing clarity; savings in filter aids; and easy cleaning—not necessary to clean out tanks by hand.

Available in ordinary steel, hard rubber, stainless steel and pure nickel construction.

Capacities from 1 pint to 5,000 g.p.h.

Write for full details today!

SPARKLER MANUFACTURING COMPANY
1214 Webster Avenue Chicago, Illinois

Supply Prices, March 31, 1941

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.			
COPPER: Cast, elliptical, 15" and longer	25 1/4 c. per lb.	ZINC: Cast, 99.99, 16" and over	15 1/4 c. per lb.
Electrolytic, full size, 20 1/4 c.; cut to size	20 1/4 c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus	
Rolled, oval, straight 15" and longer		cast 47c.; Rolled, depolarized	48c. per lb.
23 1/4 c. per lb.; curved	24 1/4 c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.
BRASS: Cast, 80-20, elliptical, 15" and longer	23 3/4 c. per lb.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.08	Hydrogen Peroxide, 100 volume, carboys	lb.	.16-18 1/2
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615	Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Chromic, 99%, 100 lb. and 400 lb. drums, l.c.l.	lb.	.17 1/4	Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.11
Hydrochloric (muriatic) Tech., 20°, carboys, wks.	lb.	.027	Oxide (Litharge), com., powdered, bbls.	lb.	.08 1/4
Hydrochloric, C.P., 20°, bottles	lb.	.19	Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Hydrofluoric, 30% bbls.	lb.	.06-06 1/2	Mercury Bichloride (Corrosive Sublimate), crys.	lb.	\$2.19
Nitric, 36°, carboys 1-9, wks.	lb.	.0595	Mercuric Oxide, tech., red, powder, bbls.	lb.	\$2.81
Nitric, 42°, carboys 1-9, wks.	lb.	.0745	Nickel, Carbonate, dry, bbls.	lb.	.36-36 1/2
Oleic (Red Oil), distilled, drums	lb.	.08 1/4-.09 1/4	Chloride, bbls.	lb.	.18-20
Oxalic, bbls. l.c.l.	lb.	.14	Salts, single, 425 lb. bbls.	lb.	.135-145
Stearic, distilled, double pressed, bags	lb.	.11-12	Salts, double, 425 lb. bbls.	lb.	.135-145
single pressed, bags	lb.	.10 1/2-.11 1/2	Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.057
triple pressed, bags	lb.	.13 1/4-.14 1/4	Perchloroethylene, drums, l.c.l.	lb.	.08 1/4
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245	Phosphorus, red, cases	lb.	.44
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.16-17 1/2	yellow, cases	lb.	.23-25
Butyl-normal, l.c.l., drums	lb.	.105	Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.32	Potassium Bichromate, crystals, casks	lb.	.09 1/4
Diacetone, tech., drums, l.c.l.	lb.	.10	Carbonate (potash) calc., wks, drums	lb.	.06 3/4
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.38	Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Propyl-Iso, 99%, drums, l.c.l.	gal.	.43-47	Pumice, ground, 1 1/2 F. & coarser, bbls., wks.	lb.	No price
Propyl-Normal, drums, wks.	gal.	.70	Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	\$180.
Alum, ammonia, granular, bbls., works	lb.	.035	Rochelle Salts, crystals, bbls.	lb.	.40
Potash, granular, bbls., works	lb.	.0375	Rosin, gum, B, bbls., dock	lb.	.0213
Ammonia, aqua, 26°, carboys	lb.	.05 1/4	Silver, Chloride, dry, 50 oz. lots	oz.	.37 1/2
Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks.	lb.	.0445	Cyanide, 100 oz. lots	oz.	.33 1/4
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.65	Nitrate, 100 oz. lots	oz.	.24
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40	Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0208
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17	Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Barium Carbonate, pted., bags, l.c.l., works	lb.	.025	Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Benzene (Benzol), 90%, drums, works	gal.	.19	Hyposulphite, crystals, bags, wks.	lb.	.0250
Butyl Lactate, drums	lb.	.235	Metasilicate, granular, 1-9 bbls.	lb.	.0335
Cadmium Oxide, l.c.l., bbls.	lb.	.95	Nitrate, rfd., gran., bbls., wks.	lb.	.029
Calcium Carbonate (Ppted. chalk), c.l., wks.	lb.	.02 3/4	Phosphate, tribasic, tech., bbls., wks.	lb.	.0295
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05 1/4	Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0560
Carbon Tetrachloride, l.c.l., drums	gal.	.73	Sesquisilicate, 1-9 drums	lb.	.0425
Chromic Sulphate, scale, 100 lb. drums	lb.	.45	Stannate, drums	lb.	.375
Cobalt Sulphate, drums	lb.	.71	Sulphate, anhydrous, bbls., works	lb.	.0215
Copper, Acetate (verdigris), bbls.	lb.	.22-23	Sulphocyanide, drums	lb.	.28-47
Carbonate, 52-54%, bbls.	lb.	.16 1/4	Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.0335
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Tin Chloride, crystals, kgs.	lb.	.40
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535	Toluene (Toluol), 2°, ind., drums, works	gal.	.32
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.53 1/2	Trichlorethylene, drums, l.c.l., zone 1	lb.	.08 1/2
Crocus Martis (iron oxide) red, bbls.	lb.	.03	Tripoli, air floated, bgs., c.l., wks.	ton	\$26.00
Dibutyl Phthalate, drums, l.c.l.	lb.	.195	Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.38-40
Diethylene Glycol, drums, l.c.l., works	lb.	.155	Bees, yellow, crude, Brazil, 100 lbs.	lb.	.32 1/2
Dextrin, white, bags, F.O.B. Chicago	lb.	.0385	Carnauba, refined, bags	lb.	.65-66
Emery (Turkish)	lb.	.07	Montan, bags	lb.	No prices
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.075	Spermaceti, blocks	lb.	.24-25
Ethylene Glycol, l.c.l., drums, works	lb.	.15 1/2-18 1/2	Whiting, precipitated, bags, l.c.l.	ton	\$20.00
Monoethyl ether, dms., l.c.l., wks.	lb.	.145	Xylene (Xylol), ind., returnable drums, works	gal.	.31
Gold, Chloride, yellow, bottles	oz.	\$19.00	Zinc, carbonate, tech., bbls.	lb.	.14-16
Cyanide, potassium 41%, bottles, wks.	oz.	\$14.20-\$15.45	Cyanide, 100 lb. kegs	lb.	.33
Gum, Arabic, white, powder, bbls.	lb.	.18-20	Chloride, tech., granular, drums, c.l., wks.	lb.	.05 3/4
			Sulphate, crystals, bbls., l.c.l.	lb.	.039

FILTERS

"Leak Proof"

"Corrosion Proof"

Designed to meet the exact demands of modern fine filtration practice of Electroplaters for solution of all kinds.

For Bright Nickel Plating Solutions all parts contacting solutions are lined with cured rubber of tested and approved quality. Filter baffles are of molded hard rubber. Pumps and fittings are of DURIRON. Also several other setups.

(Note: This corrosion proof and non-contaminating construction is a vital requisite if equipment is intended for filtration of Bright Nickel Solution).

INDUSTRIAL FILTER & PUMP MFG. COMPANY

3017 West Carroll Avenue

Chicago, Illinois

SALT SPRAY CORROSION TEST EQUIPMENT

For testing—Electroplated or coated metals at 95 deg. Fah. in accordance with Army, Navy and Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1938. Also for controlled temperatures at any degree.

Testing Cabinet lined throughout with rubber. Made in 4 sizes. Complete units having pure sheet nickel cabinets also supplied for testing Electroplated parts, lacquers, paints, etc., at normal cabinet temperatures. Made in 2 sizes.

"Write for New Literature and particulars."

Less Alkali

... MORE

WORK

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